



RECORD OF DECISION
SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

AQUA-TECH ENVIRONMENTAL INC.
(GROCE LABS) SITE
GREER, SPARTANBURG COUNTY, SOUTH CAROLINA

PREPARED BY:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA, GEORGIA

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LIST OF ACRONYMS and ABBREVIATIONS

AOC - Administrative Order by Consent
AMLS-Above Mean Sea Level
ARAR- Applicable or Relevant and Appropriate Regulations
BGS or bgs - below ground surface
BRA- Baseline Risk Assessment
CERCLA-Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR - Code of Federal Regulations
COC-Chemical of Concern
COPC-Chemicals of Potential Concern
CRA-Conestoga Rovers and Associates
EU-1 - Exposure Unit One
EU-2 - Exposure Unit Two
EPA - Environmental Protection Agency
EPC - Exposure Point Concentration
EPS- Exposure Pathway Scenarios
ERA- Ecological Risk Assessment
ESI - Expanded Site Inspection
ET- Exploratory Trenching
FML - Flexible Membrane Liner
FS - Feasibility Study
ft/day - foot per day
ft/s-foot per second
ft/yr - foot per year
ft³/yr- cubic feet per year
in/yr - inches per year
GLI - Groce Labs Incorporated
HRC - Hydrogen Release Compound
HEAST - Health Effects Assessment Summary Tables
HI-Hazard Index
HQ-Hazard Quotient
IRIS-Integrated Risk Information System
LG - Landfill Gas
MCL- Maximum Contaminant Level
MEP- Maximum Extent Practicable
µg/L - Micrograms per liter
mg/kg- milligrams per kilogram or parts per million (ppm)
mg/cm² - milligrams per square centimeters
mg³/kg - cubic meters per kilogram
MNA - Monitored Natural Attenuation
MSW - Municipal Solid Waste
MSWL - Municipal Solid Waste Landfill

NCEA - National Center for Environmental Assessment
NCP - National Contingency Plan
NPL - National Priority List
O&M - Operation and Maintenance
PCBs - Polychlorinated Biphenyls
PID- photoionization detector
ppb -parts per billion
ppm - parts per million
ppmv - part per million per volume
PRG - EPA Region 9 Preliminary Remediation Goals
PRPs - Potentially Responsible Parties
RAO - Remedial Action Objectives
RCRA - Resource Conservation and Recovery Act
RD/RA - Remedial Design/Remedial Action
RG - Remedial Goal
RI - Remedial Investigation
RI/FS - Remedial Investigation/Feasibility Study
ROD - Record of Decision
RPM- Remedial Project Manager
SARA- Superfund Amendments and Reauthorization Act of 1986
SB - Soil Boring
SCDHEC - South Carolina Department of Health & Environmental Control
SC MAACs - South Carolina Maximum Ambient Air Concentrations
SDWA - Safe Drinking Water Act
SMCLs - Secondary Maximum Contaminant Levels
SVOCs Semi -Volatile Organic Compounds
TAL - Target Analyte List
TCL - Target Compound List
TEQ- Toxicity Equivalence Quotient
UAO - Unilateral Administrative Order
 $\mu\text{g/kg}$ - micrograms per kilogram
 $\mu\text{g/L}$ - micrograms per Liter
US - United States
USGS - United States Geological Service
VOCs - Volatile Organic Compounds
 yd^3 cubic yards
< less than

PART I: THE DECLARATION

A. Site Name and Location

Aqua-Tech Environmental Inc. (Groce Labs) Site
The EPA Site Identification Number is SCD058754789
Greer, Spartanburg County, South Carolina

B. Statement of Basis and Purpose

This decision document presents the Selected Remedy for the Aqua-Tech Environmental Inc. (Groce Labs) Site which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record for the Site.

The State of South Carolina concurs with the Selected Remedy.

C. Assessment of Site

The response action selected in this Record of Decision is necessary to protect the public health or welfare and the environment from actual or threatened releases of hazardous substances to the environment.

D. Description of Selected Remedy

The Selected Remedy employs the Presumptive Remedy for CERCLA municipal landfills (containment) as one of five (5) major components, which are briefly described below:

- 1) Site Capping using a combination of a RCRA Subtitle C Cover and RCRA Subtitle D soil cover for different portions of the municipal landfill to ensure all municipal waste is isolated from exposure and provide an extra level of protection in areas where the greatest concentrations of VOCs were reported;
- 2) In Situ Soil Treatment in the former Process Distillation Area to reduce the mass of VOCs in shallow soils throughout this area;
- 3) In Situ Groundwater Treatment by chemical injection to immediately reduce the contaminant mass and enhance the long term biodegradation of residual VOCs in groundwater. Once in situ treatment is complete, final remediation of groundwater will be achieved through natural attenuation;
- 4) Routine groundwater monitoring and Site inspections to assess the effectiveness and integrity of the selected remedial alternative; and,

- 5) Institutional Controls to restrict use and development of the Site to minimize public exposure to residual contaminants, and to ensure the long-term integrity of the remedy.

E. Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action (unless justified by a waiver), is cost effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. For soil and groundwater, this remedy satisfies the statutory preference for treatment as a principal element of the remedy (*i.e.*, it reduces the toxicity, mobility, or volume of hazardous substances as a principal element through treatment).

The Selected Remedy includes a Presumptive Remedy for the landfill at the Site. Therefore, upon completion of this remedy, hazardous substances, pollutants, or contaminants will remain on-site under the landfill cap and will limit use of the property. Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after commencement of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

F. Data Certification Checklist

The following information is included in the Decision Summary section of this Record of Decision (Part 2). Additional information can be found in the Administrative Record file for this Site.

- Chemicals of concern and their respective concentrations (pages 37, 38)
- Baseline risk represented by the chemicals of concern (page 44, 45)
- Clean-up levels established for chemicals of concern and the basis for these levels (page 81, 82)
- How source materials constituting principal threats are addressed (page 70)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the Baseline Risk Assessment and ROD (page 34)
- Potential land, groundwater and surface water use that will be available at the site as a result of the Selected Remedy (page 80)
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (pages 77-79)

- Key factors that led to selecting the remedy (pages 61-69,76)

G. Authorizing Signature

Winston A. Smith, Director
Waste Management Division
United States Environmental Protection Agency, Region 4

Date

PART II: THE DECISION SUMMARY

A. SITE NAME, LOCATION, AND BRIEF DESCRIPTION

A.1 Site Identification and Location

The United States Environmental Protection Agency's (EPA) Identification Number for the Aqua-Tech Environmental Inc. (Groce Labs) Site (the "Site") is SCD058754789. The Site is located on Robinson Road near its intersection with South Carolina Highway 290, approximately 3 miles east of the City of Greer, and approximately 1 mile west of the City of Duncan, South Carolina (Figure 1). The Site's coordinates are latitude 34° 56' 10.0" N and longitude 82° 10' 15" W.

A.2 Lead and Support Agencies

The lead agency for the CERCLA regulatory response at the Site is EPA. The South Carolina Department of Health and Environmental Control (SCDHEC), Office of Environmental Quality Control, is the support agency.

A.3 Source of Cleanup Monies

The monies for the response actions at the Site have largely come from the Aqua-Tech Potentially Responsible Party Group (PRP Group). Under a Unilateral Administrative Order (UAO), the PRP Group was obligated to pay for the cost of the Removal Action. Under an Administrative Order on Consent (AOC) for the Remedial Investigation and Feasibility Study (RI/FS), the PRP Group is obligated to pay USEPA's oversight costs of the RI/FS as well as the cost of the RI/FS. EPA intends to negotiate a consent decree for Remedial Design and Remedial Action (RD/RA) with the PRPs.

A.4 Site Description

The Site occupies 61.56 acres of land. A former Resource Conservation and Recovery Act (RCRA) hazardous waste treatment and storage facility previously occupied approximately 20 acres of the Site. A closed municipal solid waste landfill (MSWL) occupies approximately 10 acres of the Site. The RCRA treatment and storage facility overlapped with portions of the closed MSWL. The primary operating areas of the RCRA facility are described in Section A.4.1 and illustrated on Figure 2.

The Site is presently abandoned and the land surrounding the Site is generally wooded, with the closest residences located approximately 650 feet to the east of the Site on Robinson Road. There are several small businesses and residences to the north of the Site on SC Highway 290. The area west of the Site is former farmland. The nearest surface water body

is Maple Creek, which is located on the southern boundary of the Site. There are several residential neighborhoods consisting of a few houses each within a 1-mile radius of the Site. The Site is zoned as commercial/industrial and is located within the “Airport Environs Area” as defined by the *Greenville - Spartanburg Airport Environs Area zoning Ordinance, dated March 29, 1996*. This zoning ordinance precludes future residential development use of the Site.

A.4.1 Areas of Operations

The primary former areas of operation that were considered to be potential sources of contamination are as follows:

- the 501-09 Area;
- 502A, 502B, 503 Areas;
- 504 Area;
- 505 Area;
- 601/602 Area;
- PC13 Area; and,
- Process Distillation Area including adjacent Incineration Area and Tank Storage Area.

501 Building and Area

The 501 Building was used for storage of explosive materials and for the storage of lab pack waste. Additionally, flammable solvent materials were stored in this area. All materials stored in this building were reportedly mutually compatible; therefore, no internal separations were present in the storage facility.

The 501 Loading/Unloading Area is a concrete platform on the east side of the 501 Building. This area was used to load and unload non bulk shipments received by the facility during operation. The uncurbed, uncovered pad is approximately 100 feet by 25 feet. The loading dock area was used throughout the removal by SCDHEC, USEPA, the PRP Group, and respective contractors. Materials ranging from flammables, organics, reactives, acids, and bases have been shipped off-site from this location.

The 501 Building and area is located on the closed MSWL.

502A, 502B, 503 Areas

These areas were used for interim status outdoor drum storage during the operation of the facility. In addition to storage of acids, the northern portions of these areas were used for drummed product storage. Three portions of these areas are covered with 4 inch thick concrete pads with sumps. All of the sumps were filled with sand and covered with concrete during the removal action.

504 Area

The 504 Area was used for interim status outdoor storage of oxidizers, and a portion of this area is covered with a 4 inch thick concrete pad. In addition to outdoor storage, some oxidizers were stored in a metal storage trailer during operation of the facility. Area 504 was excavated into a hillside and sloped to the southwest to keep water away from the oxidizers.

505 Area

The 505 Area was used as a process and storage area for both cyanide and poison wastes, including electroplating wastes and wastes containing arsenic and mercury. A portion of the area is covered with a 4 inch thick concrete pad.

601/602 Area

This area was used for interim status outdoor drum storage during the operation of the facility. The two portions of this area include approximately 2 acres and contained poisonous and corrosive wastes in separate areas divided by a dirt roadway.

PCl₃ Area

The PCl₃ Area was used to neutralize phosphorus trichloride production waste with a sodium hydroxide solution. The area is located southwest of the Process Distillation Area. This area is covered with a thick concrete pad approximately 100 feet by 50 feet. The curbed pad was used for staging 55 gallon drums containing acid and base waste materials.

Process Distillation Area (Including Incineration and Tank Storage Areas)

The Process Distillation Area was the primary area for performing fuel blending and recycling operations for the facility. It is located over the closed MSWL. The Process Distillation Area supported as many as 40 tanks during operation of the facility. The process and storage vessels in this area were not permanent during operation of the facility; and when not in use, they were stored in the nearby equipment yard. The area is covered with a thick concrete pad measuring approximately 100 feet by 80 feet. The concrete pad has a secondary containment structure consisting of concrete block walls approximately 2 feet high.

The Incineration Area was located in the northwest corner of the Site adjacent to the Process Distillation Area and contained a sodium reactor that was used to react sodium metal with waste to produce sodium hydroxide solutions and an incinerator used to melt off specification hand grenades, bullets, and blasting caps. A portion of the area is covered by a concrete pad with secondary containment structures.

Tank Storage Areas 1 and 2 contained approximately six to ten tanks during the operation of the facility. Hazardous materials were pumped into various tanks on-site until proper disposal was arranged. The area is covered with a 4 inch thick concrete pad with secondary containment. The area is located adjacent to the Process Distillation Area over the closed MSWL.

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

B.1 Activities that led to the Current Problems

Prior to the 1940's, activities at the Site are unknown. The Site was used for waste management activities as early as the 1940's when local residents used the property for general dumping. It is unknown who owned the Site before the 1950's or 1960's when the City of Greer purchased the 35-acre parcel of Site property. From 1963 until 1968, the City operated a MSWL covering approximately 10 acres of the Site. The MSWL was subsequently closed and capped with clay in the early 1970's.

In December 1974, Groce Laboratories, Incorporated (GLI) purchased the 35 acres from the City of Greer and began operating an interim status hazardous waste treatment, storage, and disposal facility under RCRA. From the mid-1970's until 1987, the facility accepted explosives, laboratory pack materials, cyanides, water reactives, oxidizers, acids and bases, fuels and gas cylinders. The facility also received some biomedical wastes and low-level radioactive wastes.

The facility's primary processes consisted of the treatment of phosphorus trichloride, the processing and storage of lab pack materials, the recovery of metals (primarily off-specification ammunition), the recovery of solvents, the processing and storage of compressed gas cylinders, the management of containers containing hazardous materials, neutralization of acids and bases, and the blending of fuels. Aqua-Tech Environmental, Inc. (Aqua-Tech) purchased the operations in April 1987 and continued to accept, store, and treat most hazardous wastes as well as a variety of other solid wastes. Both GLI and Aqua-Tech were regulated by RCRA.

B.2 Previous Investigations

Historic investigations conducted at the Site have included monitoring well installation, groundwater sampling and analyses, and the sampling and analysis of residential water supply wells, surface soil, subsurface soil, surface water, and sediment. A summary of the previous investigations including the sampling program dates, sample analyses, and numbers of samples collected and analyzed is presented in Table 1.

GLI and Aqua-Tech conducted a total of four ground water assessments and hydrogeologic investigations on-site between 1985 and 1990. The assessments were required and approved by SCDHEC to determine the potential effects of municipal waste and hazardous waste operations on groundwater beneath the Site. During the EPA Region 4 removal and post-removal activities, consultants for the Aqua-Tech PRP Group collected surface water and stream sediment samples from Maple Creek and sampled three residential wells east of the

Table 1

**SUMMARY OF PREVIOUS INVESTIGATIONS
AQUA-TECH SITE REMEDIAL INVESTIGATION/FEASIBILITY STUDY
GREER, SOUTH CAROLINA**

<i>Media</i>	<i>Date</i>	<i>Number of Sample Points</i>	<i>Sample Analyses</i>
Groundwater	Sep-85	6	PPL ⁽¹⁾ , barium
	Oct-87	6	pH, specific conductance, temperature, TOC, TOX, PPL VOCs, phenols
		12	pH, specific conductance, temperature, TOC, TOX, PPL ⁽¹⁾ except PCBs/pesticides/herbicides, phenols
	Jun-88	30	pH, specific conductance, temperature, PPL VOCs, total phenols
	Dec-89	30	pH, specific conductance, temperature, VOCs, phenols, total metals
	Jul-92	11	TCL/TAL
Residential wells	1992/1993	3	TCL/TAL
Sediment	1992/1993	3	TCL/TAL
Surface water	1992/1993	3	TCL/TAL
Surface soil	Aug-93	18 ⁽²⁾	TCL/TAL

Notes:

⁽¹⁾ Metals analyses for dissolved fraction only.

⁽²⁾ Ninety-seven (97) samples were collected from 18 operational areas.

PCBs Polychlorinated Biphenyls.

PPL Priority Pollutant List.

TAL Target Analyte List.

TCL Target Compound List.

TOC Total Organic Compound.

TOX Total Organic Halides.

VOCs Volatile Organic Compounds.

CRA 13926(2)R1

Site on seven occasions between June 1992 and December 1993 when the Removal Action was undertaken by the PRP Group. The consultants for the PRP Group also collected surface soil samples in August 1993 to assess the nature and extent of affected soils remaining after the Removal Action. The results of these investigations indicated that:

- soil remaining after the completion of the Removal Action exhibited the presence of contaminants, however, no further removal action was required;
- organic chemical compounds, primarily trichloroethene and tetrachloroethene, were present in groundwater beneath the Site;
- organic chemical compounds, primarily trichloroethene and 1,2-dichloroethene, were present in surface water in the Site drainage ditch but not in surface water from Maple Creek; and,
- organic chemical compounds, primarily bis(2-ethylhexyl)phthalate, were present in sediment in the drainage ditch but were not present in the sediments of Maple Creek.

B.3 Remedial Investigations

The field work for the Remedial Investigation (RI) occurred in four phases. Implementation of Phase I began on May 26, 1998, and was concluded on July 2, 1998. The activities conducted during Phase I included sampling of surface and subsurface soil, groundwater, surface water, sediment, and landfill gas, installation of exploratory trenches, aquifer testing, water supply survey, and Site survey. Implementation of Phase II began on October 26, 1998, and was concluded on November 19, 1998. Phase II activities included additional groundwater sampling and Site survey, hydraulic conductivity testing, and installation of exploratory borings. Phase III activities consisted of a supplemental sampling program, performed between May and July 2000. The Phase III supplemental data collection activities consisted of temporary well installation and sampling, residential well sampling, re-sampling of selected wells and test trenching. The Phase III supplemental data collection activities were performed to:

- further characterize and delineate groundwater contamination observed in MW- 20;
- confirm groundwater data for MW-23 [primarily due to inconsistencies with bis(2-ethylhexyl)phthalate in split sample data from the previous sample round]; update nearby residential well data;
- confirm southern limits of landfill; and,
- obtain additional groundwater data to facilitate a preliminary assessment of natural attenuation processes occurring at the Site.

Phase IV of the RI investigation was performed in December 2001. Phase IV supplemental RI investigation activities consisted of new well installation and sampling, re-sampling of the existing monitoring well network, and performance of a focused sub-surface soil investigation in selected former operating areas described in sub-section A.4.1. The primary objectives of the Phase IV supplemental investigation activities were as follows:

- determine the degree of contamination (if present) beneath the former Aqua-Tech Environmental operating areas that represent potentially significant contaminant sources based on types and volume of materials handled and/or nature of operations;
- further define groundwater quality and/or hydraulics on the east boundary of the Site, southwest of the Site and south of Maple Creek; and,
- update the Site's groundwater quality database.

Figures 3, 4, 5, 6 & 7, in Appendix A, display prior investigation and RI sample locations, including the delineation of the landfill. The results of RI investigation activities are summarized in the sub-sections that follow.

B.4 Enforcement Activities

SCDHEC and EPA Region 4's RCRA compliance program inspected the facility on numerous occasions during the 1980's and noted a number of violations of state and federal laws and regulations. From 1982 through 1991, GLI, and its successor Aqua-Tech entered into six Administrative Orders on Consent with SCDHEC to address regulatory violations at the Site. Deficiencies noted by SCDHEC and EPA during inspections included the unpermitted discharge of hazardous materials to the environment, the storage of hazardous waste in unpermitted areas, unmarked containers of hazardous waste, bulging containers holding hazardous waste, hundreds of waste containers being stored in violation of applicable land disposal restrictions, and the accumulation of rain water in such a manner as to permit its contact with hazardous materials.

On March 4, 1990, a fifty-five gallon drum of hazardous waste caught fire at the Site. A firefighter responding to the fire was overcome by the dense cloud of black smoke generated by the fire and ninety people were evacuated. Another incident occurred when four drums of off-specification igniter sustainer mixtures were sent to the facility. When they inspected the containers, SCDHEC officials discovered that the material was improperly packaged. While repacking the material on April 19, 1990, two (2) drums of off-specification igniter sustainer mixtures detonated, severely injuring two (2) people and destroying a truck and a towmotor. On July 10, 1990, Aqua-Tech held a controlled explosion to destroy two (2) more drums of igniter sustainer mixtures, prior to which thirty two (32) nearby residents were evacuated for safety.

On August 27, 1991, EPA Region 4's RCRA compliance program and SCDHEC jointly inspected the facility and reported the following conditions: (1) the solvent recovery containment area held potentially contaminated water collected from several drum storage areas (this water was approximately two feet deep, which was at the level of the bottom of several storage tanks and within several inches of overflowing the containment area); (2) numerous containers of hazardous waste were open; (3) hazardous waste containers were leaking or were deteriorating; (4) hazardous waste containers were warmer than other metal containers on the compatible acid storage pad, indicating an exothermic reaction with contaminated rainwater; and, (5) a container of phosphorus trichloride was reacting and

releasing a hazardous gas. The inspectors also observed approximately 430 gas cylinders, containing flammable materials, poisons and freon, in varying deteriorating conditions about the Site. During the inspection, Aqua-Tech personnel reported that an employee had just been overcome by fumes and seriously injured in the reactive area while unpacking laboratory pack materials.

Following the inspection described above, SCDHEC issued an Emergency and Administrative Order, Number 91-52-SW, to Aqua-Tech under which SCDHEC determined that Aqua-Tech Environmental, Incorporated, had failed to operate the facility in compliance with South Carolina laws and regulations and with the Orders which Aqua-Tech had previously entered into with SCDHEC. SCDHEC concluded in the Order that the Aqua-Tech facility is an uncontrolled hazardous waste site. In the Order, SCDHEC revoked the facility's interim status and ordered the facility immediately to cease its receiving, shipping, recycling, and treatment activities. Thereafter, SCDHEC denied the facility's Part B application for an operating permit.

On September 12, 1991, SCDHEC requested assistance from EPA in order to address the contamination at the Site. EPA Region 4 assumed responsibility for conducting the cleanup at the Site on January 20, 1992. In May 1992, EPA issued a UAO to ninety-eight PRPs requiring them to perform cleanup activities. The PRP group provided Site security, removed drummed waste cylinders, lab packs, and treatment residuals, and performed limited soil sampling at the Site. The Removal Action was conducted by the PRPs under the direct oversight of EPA. The Removal Action was completed in early 1994. This Site was listed on the National Priorities List (NPL) as part of Final Rule #13 published in Federal Register on December 16, 1994.

Although the removal of drums, cylinders and solid and liquid wastes reduced the potential for exposure to contaminated materials at the Site, additional investigation was required to further characterize the Site. On September 26, 1995, the Aqua-Tech PRP Group signed an AOC with EPA agreeing to fully fund and conduct a RI/FS at the Site. EPA obtained access to the Site by court order in April 1998, and authorized the PRP Group to proceed with the RI/FS work.

C. COMMUNITY PARTICIPATION

The RI/FS Report and the Proposed Plan for the Site were made available to the public in July 2003. They can be found in the Administrative Record file and the information repository maintained at the EPA Docket Room in Region 4 and at the Middle Tyger Branch Library. The notice of the availability of these two documents was published in the *Greenville News* on July 27 and August 3, 2003. A public comment period was held from July 27 to August 25, 2003. In addition, an availability session and a public meeting was held on August 5, 2003 to present the Proposed Plan to a broader community audience than those that had already been involved at the Site. At this meeting, representatives from EPA and SCDHEC answered questions about problems at the Site and the remedial alternatives.

EPA also used this meeting to solicit a wider cross-section of community input on the reasonably anticipated future land use and potential beneficial ground-water uses at the Site. EPA's response to the comments received during this period is included in the Responsiveness Summary, which is part of this Record of Decision.

D. SCOPE AND ROLE OF ACTION

The selected remedy described in this ROD is the final Site remedy which takes into consideration prior remedial and removal responses, including the lengthy RI/FS. The Removal Action was completed in early 1994. This is the first and only operable unit for the Site. The Site remedy is intended to reduce future unacceptable risks to human health and the environment by preventing or minimizing further exposure to contaminated air, soils and groundwater impacted by the closed MSWL and the former Aqua-Tech operation. In summary, the remedy provides for the construction of an engineered containment cover (cap) in accordance with the Presumptive Remedy combined with in situ treatment of soil to primarily prevent or mitigate direct human exposure to Site soils and/or the MSWL contents. Furthermore, the selected remedy will control migration of contaminants from the Site to surface water by eliminating contact of storm water runoff with MSWL contents and Site soils. The remedy provides for the restoration of the contaminated groundwater by implementing in situ treatment of groundwater to attain clean-up levels after 3 to 5 years. Institutional controls will be implemented to control Site use. Environmental monitoring will be implemented to evaluate the effectiveness of the remedy.

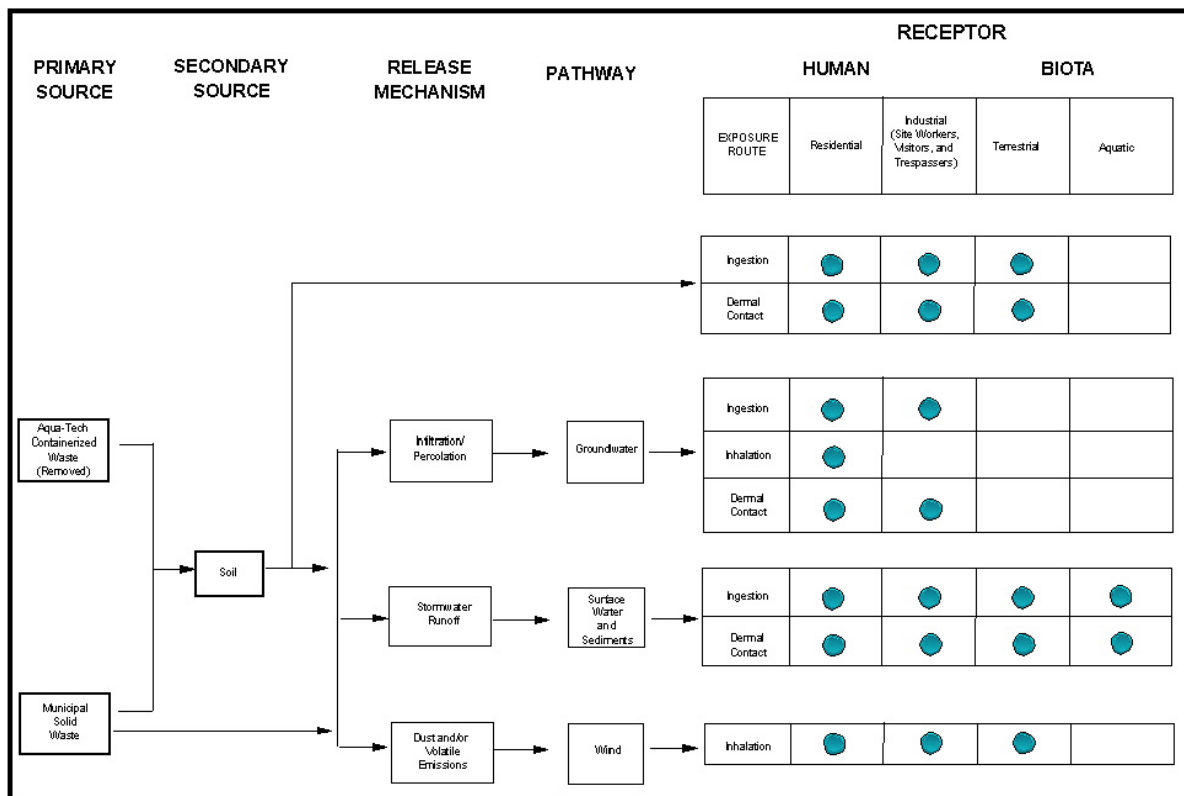
This is the only ROD contemplated for this Site. This decision document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Contingency Plan (NCP).

E. SITE CHARACTERISTICS

E.1 Conceptual Site Model

The conceptual Site model used to develop an understanding of the Site and to evaluate potential risks to human health and the environment is presented in Figure 8 and summarized below. The primary remaining known source at the Site is the closed MSWL. Affected surface soils remaining after the source removal may act as a secondary source.

Figure 8 - Conceptual Site Model Developed for the RI



The release mechanisms include:

- Infiltration/percolation of precipitation through the contaminated soils and landfill waste to groundwater;
- Storm water runoff over contaminated soils that could transport contaminants to surface water and sediments;
- Flow of contaminated groundwater to surface water and sediments; and,
- Dust and/ or volatile emissions.

Site visitors and area residents are potentially exposed to contaminated surface water and sediments via ingestion and dermal contact, and to airborne constituents through inhalation. Area residents are also potentially exposed to contamination in groundwater through direct contact as well as ingestion and inhalation of volatilized contaminants. Site visitors are potentially exposed to contaminated soil through ingestion and dermal contact, and to airborne constituents through inhalation.

Potential environmental receptors at the Site include terrestrial biota which may be directly exposed to contaminated soil through ingestion or dermal contact; and aquatic biota which may be exposed to contaminated surface water and sediment through ingestion and dermal contact.

E.2 Site Features

The Site is characterized by low rolling hills composed of weathered bedrock. The topography slopes to the south, toward Maple Creek. The elevation ranges from approximately 752 feet above mean sea level (AMSL) at the southeast of the Site near Maple Creek, to approximately 872 feet AMSL in the vicinity of monitoring well MW-14 at the northwest corner of the Site.

The MSWL encompasses approximately 10 acres of the Site. The extent of the landfill is shown on Figure 7. There are no storm sewers located on or within 1000 feet of the Site. A septic tank and drain field for sanitary waste are located west of the former administration area.

E.3 Site Geology

The stratigraphic units encountered on the Site include:

- i) landfill cover and waste material;
- ii) residuum/saprolite; and,
- iii) bedrock.

The characteristics of these geologic units were determined based upon the stratigraphic logs of the 42 monitoring wells and test borings installed at the Site. In general, the geology of the Site was found to be consistent with the regional setting. In order to aid in the discussion of the Site geology, four geologic cross sections were prepared based on the Site borehole logs. The locations of the cross sections are shown on Figure 9 and are presented on Figures 10 to 13. Geologic Cross sections A A' and D D' run approximately parallel to the direction of groundwater flow and Cross sections B B' and C C' run perpendicular to groundwater flow.

E.3.1 Landfill Cover and Waste Material

The landfill area was delineated as part of the RI activities based on a prior test trenching program and was further refined during the Phase IV subsurface investigation. The extent of the landfill is estimated to be 10.1 acres, as shown on Figure 7.

Data collected during the RI and previous investigations has shown that the landfill is partially covered by a hard, dense clay cover of variable thickness. Boring logs for the monitoring wells drilled within the limits of the former landfill (MW- 10, MW- 10A, MW-

9, MW- 9A, MW- 9B, MW- 8, MW- 8A, MW- 8B, MW- 7, and MW- 7A) indicate that the thickness of the landfill ranges from 16.5 feet at MW- 8/8A to 40 feet at MW- 9B, with an average depth of 24.8 feet. Based on the estimated area of the former landfill and the average thickness of waste material, the estimated volume of waste in the former landfill area is approximately 320,000 cubic yards. This calculation likely overestimates the volume of municipal waste in the landfill since it is based on borings through deeper portions of the landfill and does not account for volume losses from side slopes around the perimeter of the landfill.

Based on the groundwater level measurements, it appears that the water table currently encroaches upon the municipal solid waste material (see Cross section A A', Figure 10).

E.3.2 Residuum/Saprolite Unit

The uppermost geologic unit at the Site in the areas outside the landfill are residual soils and saprolite. According to previous assessments, residual soils compose most of the land surface, with decomposed bedrock exposed on the western portion of the Site.

According to the stratigraphic logs, the residual soils and former landfill are underlain by saprolite, which is thickest in the eastern portion of the property. The saprolite layer ranges from a few feet thick near the southern and western boundaries to over 100 feet near the center of the Site in the vicinity of wells MW- 2A and MW- 9B. The saprolite located in the eastern part of the Site is the most typical and appears to be derived from a highly weathered gneiss. It consists of fine to medium grained micaceous and dense sand with traces of clay and silt, and it has been naturally stained to yellow orange.

The thinner less abundant saprolite located in the southern and western part of the Site appears to be decomposed granite. It consists of a black and white, fine to coarse grained sand with traces of mica and orange red staining. The staining is a result of the movement of water and minerals, and is not related to Site activities.

Highly decomposed and fractured black rock was identified beneath the saprolite in two Site boreholes (MW- 6A and MW-11A). These may indicate the presence of diabase dikes beneath the Site.

E.3.3 Bedrock Unit

Bedrock at the Site consists of granitic gneiss. The depth to bedrock across the Site varies from a few feet below land surface near the southern and western boundaries to over 100 feet below land surface near the center of the Site in the vicinity of wells MW- 2A and MW- 9B. At exploratory boring EB-2, bedrock was encountered at 84 feet below land surface. Bedrock was not encountered at exploratory boring EB-1, which was drilled to 62 feet below land surface. This boring could not be drilled deeper using the air rotary method due to the large volume of water being generated while advancing the borehole. However, during the

installation of monitoring well MW- 6A, which is located approximately 25 feet northwest of exploratory boring EB-1, bedrock was encountered at approximately 65 feet below land surface using mud rotary drilling techniques. Also, the interval from 70 to 90 feet below land surface at MW- 6A was cored. These data, indicating that bedrock is at least 65 feet deep, were used for Site characterization.

The top of bedrock contours indicate that the elevation of the bedrock ranges from 780 feet above mean sea level (amsl) in the northeast portion of the Site to 740 feet amsl in the southern portion of the Site. A top of bedrock depression is evident at monitoring wells MW- 9A, MW- 8A, and MW- 8B. The top of bedrock contour is depressed to approximately 715 feet amsl and occurs at the central portion of the landfill, just north of the Sedimentation Basin. The ground surface topography generally mimics the top of bedrock surface.

E.4 Site Hydrogeology

There are three principal hydrostratigraphic units at the Site based on the geologic unit and hydraulic head. They are:

- i) Saprolite Unit;
- ii) Shallow Bedrock Unit; and,
- iii) Bedrock Unit.

Groundwater in the saprolite unit at the Site occurs under water table conditions. The shallow bedrock and bedrock units appear to be semi-confined as demonstrated by the presence of an upward gradient versus the saprolite over most of the Site. While there are three principal hydrostratigraphic units at the Site, the distribution of contaminants in the groundwater indicates the units are interconnected and do not provide an effective impediment to the downward migration of contaminants. The following discussions are separated into saprolite, shallow bedrock, and bedrock for convenience.

E.4.1 Saprolite Unit

The saprolite unit consists of fine to medium grained, dense, micaceous sand with traces of silt and clay. The depth to groundwater at the Site ranges from 10 feet near Maple Creek to 40 feet near the northern property boundary. The saturated thickness of the saprolite ranges from 0 to 72.6 feet. This unit was encountered in most of the Site wells except for TW-5 and MW-25, on the west side of the property. Data indicates that the seasonal fluctuations at the Site are small, generally less than 4 feet. The highest seasonal fluctuations were observed in the upland area of the Site (e.g., MW-1, MW-5, and MW-15); while the smallest fluctuations were measured adjacent to Maple Creek (e.g., MW- 4, MW-10, MW-19). Examination of the available data show that groundwater flow in the saprolite discharges to Maple Creek over most of the Site. The horizontal hydraulic gradient in the saprolite ranges from 0.050 feet per foot (ft/ft) in the upland area of the Site to 0.031 feet per foot (ft/ft) near Maple Creek, with an overall gradient of 0.037 ft/ft. The average groundwater flow rate in

the saprolite unit at the Site ranges from approximately 131 feet per year (ft/yr) on the northern portion of the Site to 81 ft/yr on the southern portion of the Site.

E.4.2 Shallow Bedrock Unit

The shallow bedrock unit consists of the first-encountered groundwater within the upper weathered and/or competent granitic gneiss. Groundwater flow in the bedrock is primarily through secondary porosity (i.e., fractures, joints, and lineaments). The hydraulic conductivity ranges from 0.023 ft/day to 0.113 ft/day, with a geometric mean of 0.051 ft/day. Data indicates that the seasonal fluctuations at the Site are small, generally less than 4 feet. The highest seasonal fluctuations were observed in the upland area of the Site (e.g., MW- 8A and MW- 9A); while the smallest fluctuations were measured adjacent to Maple Creek (e.g., MW-10A). The horizontal hydraulic gradient in the shallow bedrock unit is fairly uniform across the Site, at 0.025 feet per foot. The average groundwater flow velocity in the shallow bedrock unit at the Site is approximately 4.7 ft/yr. The groundwater elevations in the shallow bedrock are, in general, slightly higher than those in the saprolite. Analysis of the June 1999 water level data shows that the mean difference between the saprolite and bedrock water levels was 1.61 feet. In June 1999, the maximum head differential was observed between MW- 8 and MW-8B (5.33 feet) and the minimum was observed at MW- 4 and MW- 4A (0.66 feet). Examination of the data indicates that vertical gradients are generally upward, indicating flow from the bedrock unit to the saprolite unit. The only location on Site where a consistent downward vertical hydraulic gradient was observed was at the monitoring well MW- 9 nest where a depression in the top of bedrock was identified. In the vicinity of Maple Creek (e.g., MW- 4A, MW- 6A, MW-10A, MW- 23A and MW-24A), upward vertical hydraulic gradients were generally measured between the bedrock and the saprolite with the exception of MW-24A. This is consistent with Maple Creek being a local groundwater discharge zone.

E.4.3 Bedrock Unit

The bedrock unit consists primarily of granitic gneiss. Groundwater flow in the bedrock is primarily through secondary porosity (i.e., fractures, joints, and lineaments). The hydraulic conductivity of the bedrock unit was determined by means of single well response tests conducted in previous investigations. A summary of the hydraulic conductivity values indicated the hydraulic conductivity ranged from 0.057 ft/day to 0.283 ft/day, with a geometric mean of .093 ft/day. Examination of the figures illustrating contours in the various units shows that groundwater flow direction in the saprolite and two bedrock units is similar. Except for a slight mounding effect seen in monitoring well MW-11A, groundwater flow beneath the Site in the bedrock unit is in a southerly direction toward Maple Creek. Based on water levels measured on December 14, 2001, the horizontal hydraulic gradient in the bedrock unit ranges from 0.056 feet per foot in the northern portion of the Site to 0.023 feet per foot, with an overall gradient of 0.035 feet per foot. The average groundwater flow velocity in the bedrock unit at the Site ranges from approximately 19 feet per year (ft/yr) on the northern portion of the Site to 7.8 ft/yr on the southern portion of the Site.

E.5 Groundwater Flow System

Infiltration of precipitation throughout the Site recharges the groundwater; however, the potential for recharge in the vicinity of the former landfill may be reduced due to the clay soil cover. Measured recharge rates from 12 sites in regolith/fractured rock in Orange County, N.C., ranged from 4.15 to 6.40 inches/year(in/yr), with a mean value of 4.90 in/yr. The USGS cited these values as representative values for a study site located in Greenville, S.C.

Groundwater in the saprolite unit flows in a south southeast direction toward Maple Creek. The direction and magnitude of the horizontal hydraulic gradients in the saprolite and bedrock units were generally consistent over the five water level measurements. Maple Creek behaves as a local discharge zone for the saprolite. In addition, shallow bedrock groundwater appears to discharge through the saprolite to Maple Creek as evidenced by the upward vertical hydraulic gradients between the saprolite and the bedrock units adjacent to Maple Creek.

E.6 Surface Water Hydrology

Natural surface drainage from the Site is to Maple Creek, which flows west to east across the southern edge of the Site. Maple Creek flows into the South Tyger River approximately 3,000 feet downstream of the Site. The drainage area for Maple Creek is approximately 10.2 square miles. The range in flow is from 5.5 ft³/s to 235 ft³/s, with a daily average streamflow of 13.4 ft³/s. There are no designated 100-year flood plains within 1,000 ft of the Site.

Surface drainage from the Site is generally routed to Maple Creek via drainage ditches. Surface drainage was modified during the Removal Action. Surface water run-on controls were installed to divert surface water from upgradient western property away from the hazardous activity area. Surface water run-off from the hazardous waste area was diverted to a sedimentation basin, both to entrap sediments and to provide emergency containment in the event of a spill during the removal activities. These controls were left intact at the conclusion of the Removal Action. The location of the sedimentation basin is illustrated on Figure 2.

E.7 Demography and Land Use

A total of 171 households were identified and surveyed within a 1-mile radius of the Site (Figure 14). Of the 171 households identified, 53 households had water wells (many of which also had public water), and 63 households did not respond to the survey. The water wells closest to the Site identified during the 1998 well survey are located east of the Site (cross-gradient) across Robinson Road. These wells were sampled six to seven times during the 1992/1993 Removal Action. The results of the analyses show that Site activities have not significantly impacted the water supply wells.

West of the Site, the nearest identified water well is located over 1/4 mile from the Site. The predominant groundwater flow direction at the Site is to the south towards Maple Creek. Maple Creek is a local discharge zone for the saprolite and bedrock groundwater. No nearby water wells were identified south of the Site. The closest well in this direction is almost a mile away on the south side of Maple Creek and is not used.

The results of the water well inventory and the residential well sampling program have shown that there are no water supply wells immediately downgradient (south) of the Site. The closest residential wells are located to the east (cross gradient) of the Site. The wells have not been significantly impacted by Site activities.

Moreover, the Site is located within the “Airport Environs Area” as defined by the *Greenville - Spartanburg Airport Environs Area zoning Ordinance, dated March 29, 1996*. This zoning ordinance precludes future residential development use of the Site.

E.8 Ecological Setting

There are two primary terrestrial plant communities present on the Site. The area of the landfill, process area, and administrative area is an old field dominated by goldenrod, ragweed, Queen Anne’s lace, and clover. Shrubs, such as sumac and willow have started to invade and become established in the old field. Kudzu was also present throughout the entire Site. Areal coverage of herbaceous vegetation was close to 100 percent.

A second major plant community on the Site is mixed deciduous/coniferous forest which includes a variety of oak, maple, pine, tulip poplar, hickory, and sumac. The ground cover within the forest is well developed. The mixed forest community occurs on those portions of the Site that have not been disturbed during the past 20 years or more.

Maple Creek is a perennial stream that flows west to east near the southern border of the landfill. Maple Creek is relatively shallow, generally less than 12 inches deep. The width of the creek varies from approximately 6 feet to 15 feet. Any wetlands on the Site are associated with Maple Creek. The area within 1/4 mile upstream of the Site has been altered as a result of installation a sanitary sewer line. The sewer line crosses Maple Creek at several locations upgradient of the Site and near the southern limit of the closed MSWL.

E.9___Nature and Extent of Contamination

E.9.1 General Sampling Strategy

As previously discussed in Section B.4, the Remedial Investigation field work was

conducted intermittently from May 1998 to December 2001. During the Remedial Investigation over 300 samples (landfill gas, surface soil, subsurface soil, groundwater, sediment and surface water) were collected to characterize the Site. Approximately 70% of the samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), Pesticides, polychlorinated biphenyls (PCBs) and metals.

E.9.2 Brief Overview of Known and/or Suspected Sources of Contamination

Based on the results of the Remedial Investigation, the two potential contaminant sources currently on the Site are: the closed MSWL and impacted soils.

The area of the closed MSWL is approximately 10.1 acres and the estimated volume of waste does not exceed 320,000 cubic yards. Based on the landfill gas samples, not all of this volume contains putrescible waste. The water table beneath the Site appears to intersect the waste. VOCs detected in landfill gas samples indicate the closed MSWL contains hazardous constituents consistent with typical mixed waste municipal landfills.

The soil data collected during the various phases of the RI and following the Removal Action have indicated a limited number of areas with exceedances of Preliminary Remedial Goals (PRGs). Operations performed in the former operating areas used for staging of wastes, located outside the footprint of the landfill, did not have a significant impact on surficial or underlying soils. The former operations appear to have impacted shallow soils only (i.e. 0 to 4 feet below ground surface (bgs) in the 501-09, and 601-02 areas. Neither area appears to represent a significant future source of contamination. Concentrations of VOCs observed in subsurface-soils beneath the Process Distillation Area, within the limits of the MSWL, appear to represent a localized source of groundwater contamination.

E.9.3 Types of Contamination and Affected Media

As early as 1985, characterization activities occurred at the Site. Moreover, the facility activities that had the potential for causing soil contamination were identified during the Removal Action. Surface soil contamination remaining after the Removal Action was complete was evaluated during a surface soil investigation conducted in 1993. During the soil investigation, the Site was divided into 18 areas (100-ft by 100-ft sampling grid) from which composite samples of soil, concrete, exposed waste, and soil beneath concrete were collected and analyzed for TAL/TCL parameters (except VOCs). Discrete samples for VOCs analyses were collected from a central sampling location in each grid section. The

results of the of the soil investigation indicated no further removal action was necessary and served as a guide to focus remedial investigation activities described below.

E.9.4 Landfill Gas

Landfill gas samples were collected at seven locations, LG-1 through LG-7. The landfill gas sample locations are shown on Figure 6. Each landfill gas sample was analyzed for VOCs, hydrogen sulfide, methane, carbon dioxide, and oxygen. In addition to the sampling and analyses described above, 21 exploratory trenches were initially excavated to define the extent of the closed municipal landfill. Additional test trenches were excavated on the southern portion of the landfill to confirm landfill presence and limits in this area. The locations of the exploratory trenches are illustrated on Figure 7. The landfill gas data from locations LG-3 and LG-7 demonstrate that no landfill gases are present and, therefore, that there may be areas within the estimated landfill boundary in which putrescible waste is not present. VOCs were detected in all landfill gas samples, however, concentrations were generally less than 1 part per million per volume (ppmv). At the sample locations within the landfill limits, VOCs were detected at concentrations greater than 1 ppmv primarily at locations LG-1 and LG-2. Benzene was detected at location LG-3 at a concentration of 1.1846 ppmv. The low concentrations of VOCs detected in the landfill gas at the majority of locations may be more reflective of residual concentrations of these chemicals in soil due to past aboveground operations than of the presence of chemicals in the landfilled materials.

Locations LG-1 and LG-2 are situated at the northern limit of the landfill in the Incineration and 501 Areas, respectively. Previous activities in these areas included the handling of various solvents and organic chemicals. The VOCs present at the highest concentrations are vinyl chloride (298 ppmv at LG-1 and 66 ppmv at LG-2), benzene (258 ppmv at LG-1 and 7.5 ppmv at LG-2), and toluene (87 ppmv at LG-1 and 4.5 mg/L at LG-2). Also present at concentrations greater than 10 ppmv are chloroethane, methylene chloride, 1,1-dichloroethane, cis-1,2-dichloroethene, ethylbenzene, and dichlorodifluoromethane.

The laboratory results are summarized in Appendix B.

E.9.5 Surface and Subsurface Soil

As previously discussed, in 1993, the Site was divided into 18 areas from which composite samples of soil, concrete, exposed waste, and soil beneath concrete were collected and analyzed for TAL/TCL parameters. During Phase I through III of the RI, additional surface soil samples were collected from locations SS-1 through SS-7 along the east side of the Site to complete the delineation of affected surface soils in this area and from location SS-8 in the Sedimentation Basin Area. Eight soil borings (SB-01 through SB-08) were also advanced and analytical samples were collected from the 0 to 1 and 4 to 5 foot bgs intervals of each boring. Soil borings SB-01 through SB-06 were located outside the northern boundary of the Site to provide data regarding potential impacts to the Site attributable to upgradient sources such as the former junkyard to the north. Soil borings SB-07 and SB-08 were located in the drainage ditch along the east side of the Site to determine whether sediments/soils in or beneath the ditch were affected by Site activities. All samples were analyzed for TAL/TCL parameters.

Additional soil samples were collected during the Phase IV RI Investigation to further assess

areas where potentially significant contamination was identified during the 1993 sampling program and/or assess subsurface impacts beneath the former Aqua-Tech operating areas (within and outside the limits of the landfill) where hazardous materials were managed.

The soil and concrete sample locations and the 1993 sampling grid are shown on Figure 6 and summarized in Appendix B.

A total of 55 soil borings were completed during the December 2001 subsurface soil investigation. The soil borings were advanced utilizing a DPT rig mounted on a four-wheel drive truck. The DPT samples consisted of 4-ft continuous soil core samples from surface to refusal or maximum sampling depth, whichever occurred first. Each sample was logged and screened with a photoionization detector (PID) meter. An on-site laboratory was used to support the investigation. Twenty percent of the total samples analyzed by the on-site laboratory were delivered via overnight courier to an off-site laboratory, for confirmation/validation of the on-site laboratory's results. The on-site and off-site laboratory results are summarized in Appendix B. The subsurface boring locations are illustrated on Figure 5.

E.9.5.1 Summary Results of the 1993 Soil Investigation and RI Phase I, II and III Soil Activities

VOCs, SVOCs, Pesticides, and PCBs were present to a limited extent in Site soils at concentrations which exceeded the residential PRGs. If the concentrations of the compounds detected in Site soils are compared to the industrial PRGs, the exceedances are further limited to:

- four VOCs in three of the 103 samples evaluated ((tetrachloroethene (PCE) and trichloroethene (TCE)) in the soil beneath the concrete pad of the Process Distillation Area, PCE in a surface soil sample, and PCE, TCE, xylene and ethylbenzene in the 501-09 waste sample);
- One SVOC in three of the 103 samples evaluated (Benzo(a)pyrene in Area 509-04 and the “soil under concrete” samples);
- one pesticide in one of the 103 samples evaluated (toxaphene in Area 509-05); and,
- three PCB Aroclors in four of the 103 samples evaluated (Aroclor 1242 in the soil beneath the concrete Process Distillation Area, and Aroclor 1254 in Areas 509-01, 509-03, and 501-06, and Aroclor 1248 in SB-07).

Aluminum, arsenic, cadmium, copper, iron, lead, and mercury were present in Site soils at concentrations which exceeded the residential PRGs and were greater than two times the

average concentration detected in background samples. If the concentrations of the compounds detected in Site soils are compared to the industrial PRGs and twice the average background concentrations, the exceedances are limited to:

- arsenic in 14 of the 103 samples evaluated, 8 on-site and 7 off-site. Five of 8 on-site samples were samples of concrete. The two exposed on-site soil samples with exceedances of the arsenic criteria were from locations 505 and SS-8. The average concentration of arsenic in these samples was 11 mg/kg. The off-site samples which exhibited exceedances of the arsenic criteria were all from soil borings advanced on the property to the north. The average concentration of arsenic in the surface soil (0 to 1 foot bgs) at these locations was 89 mg/kg;
- copper in the exposed waste in Area 501-09;
- mercury in 3 of the 103 samples evaluated. The samples of exposed soil which exhibited exceedances were from Areas ERC-01, 501-03, and 501-04. The average concentration of mercury in these exposed soils was 57.2 mg/kg; and,
- cyanide in all samples which exceeded the residential PRG.

Exceedances of the residential PRGs for arsenic and iron were detected in the samples collected from the locations east of the landfill area. However, all on-site concentrations were within the estimated ranges of background concentrations. The concentrations that exceeded PRGs are shown on Figures 16 through 25.

E.9.5.2 Summary Results of the RI Phase IV Soil Activities

Soil samples collected adjacent to or beneath the former operating areas (502A and B, 503, 504, 505 and PCL₃) situated outside the footprint of the MSWL showed no significant impact from former operations. All VOC analyses from these areas were reported as non-detect or at concentrations well below the PRGs.

Impacts to soils in the 501-09 Area and 601-02 Area were observed to be relatively shallow. Concentrations of chemicals of concern exceeding the PRGs were limited to the upper 4 feet of the soil horizon. In the 501-09 Area, the exceedances of the VOC PRGs occurred in soil borings BH-4 and BH-8. PCE and TCE were the only VOCs detected in soil at concentrations that exceeded the PRGs. Samples from boreholes BH-4 and BH-8 had reported concentrations of PCE of 441 and 300 mg/kg, respectively. TCE was detected in boring BH-8 at a concentration of 14 mg/kg. In the 601-02 Area, samples from borings BH-23, BH-26, BH-27, and BH-29 had no detectable VOCs. Borehole BH-28 was the only borehole in Area 601-02 that contained VOCs in exceedance of their respective PRGs. PCE and TCE were detected at concentrations of 17.1 mg/kg and 21.2 mg/kg, respectively. These concentrations were limited to only the first one to two feet bgs. All other boring samples from the 601-02 Area were either non-detect or well below PRGs.

The Process Distillation Area sits over the northwest portion of the closed MSWL. Soils/waste with concentrations exceeding the PRGs were delineated within the limits of the landfill. In the Process Distillation Area, the upper 8 feet of the borehole contained concentrations of PCE and TCE as high as 320 mg/kg and 1,020 mg/kg, respectively, in exceedance of PRGs. The concentrations increased with depth down to 8 feet bgs. The refusal depth of BH-19 was 15 feet bgs. The results from the bottom-sample from BH-19 indicated that all VOCs were either below PRGs or non-detect. Furthermore, PCE and TCE were also detected in exceedance of their respective PRGs in BH-18, BH-20, BH-21, and BH-22. The results of bottom samples collected from these boreholes were all reported as either non-detect or below PRG for VOCs, except for BH-18. The bottom-sample from BH 18 (9 feet bgs) had reported concentrations of PCE and TCE of 12.1 mg/kg and 15.3 mg/kg, respectively. The remaining boreholes within the Process Distillation Area provided samples that were either non-detect or contained concentrations well below their respective PRGs. Concentrations of VOCs observed in subsurface-soils beneath the Process Distillation Area, within the limits of the MSWL, appear to represent a localized source of groundwater contamination.

E.9.6 Groundwater

During Phase I and II of the RI, five new monitoring wells were installed and one round of groundwater sampling was conducted of all new and existing monitoring wells to gather analytical data to complete the definition of the extent of groundwater affected by Site activities. An additional five temporary monitoring wells were installed in off-site locations west of the Site and sampled in 2000 during the Phase III supplemental investigation performed as part of the RI. Four additional groundwater monitoring wells were installed during Phase IV of the supplemental RI investigation. The four wells were installed:

- to further delineate groundwater quality to the east, between the Site and adjacent residences with access to existing groundwater wells (MW-26);
- to further delineate off-site groundwater quality to the southwest (MW-25); and,
- to assess shallow bedrock groundwater quality immediately south of Maple Creek (MW-23A, MW-24A).

During Phase IV of the Supplemental RI investigation, all new and existing monitoring wells were sampled including the temporary monitoring wells installed during Phase III.

A complete database containing groundwater analytical data generated between 1985 and the present is contained in Appendix B.

E.9.6.1 Summary of Groundwater Activities

During Phase IV of the RI, an attempt was made to re-sample 36 existing monitoring wells and 5 temporary monitoring wells. Two of the existing monitoring wells (MW-18 and MW-18A) were dry and could not be re-sampled. Samples from all wells sampled were

analyzed for TCL VOCs. Groundwater samples collected from existing monitoring wells MW-2A, MW-4A, MW-7A, MW-8A, MW-9A, MW-9B, MW-10A, MW-11A, MW-16A, and MW-23 were also analyzed for SVOCs. In addition, groundwater samples collected from existing monitoring wells (MW-6A, MW 7, MW-9A, MW-16A, MW-23, and MW-24) were analyzed for metals. The newly installed wells, (MW-23A, MW-24A, MW-25 and MW-26) were analyzed for TCL VOCs, TCL SVOCs, metals and PCBs. The sample locations are illustrated on Figure 4.

To evaluate the impact of Site activities on groundwater quality, the concentrations of the compounds detected have been compared to USEPA Maximum Contaminant Levels (MCLs). Although not an ARAR, secondary MCLs (SMCLs) were used for comparative purposes when MCLs were not available. These criteria represent concentrations of constituents that are acceptable for drinking water sources.

Monitoring well MW-14 is a saprolite monitoring well located hydraulically upgradient of the Site. Shallow groundwater flow across the Site is from the northwest to the southeast, toward Maple Creek. The data from MW-14, which is located west of the west property boundary of the Site, represent the background quality of shallow groundwater crossing the Site and are used in the following discussions to evaluate the impact of the Site condition on groundwater quality. Total phenols were reported in MW-14 at a concentration of 20 µg/L during the Phase III RI sampling event (04/19/00); the source of the phenols in the upgradient well is not known.

E.9.6.2 Groundwater Characterization

The organic chemical compounds detected in both the RI and Phase IV supplemental groundwater samples include SVOCs, and VOCs. Pesticides were detected in the initial RI groundwater samples. The Phase IV supplemental groundwater samples were not screened for pesticides. No PCBs were detected in any RI groundwater sample. The concentrations that exceeded the MCLs are shown on Figures 26 through 31. The locations of the cross sections are shown on Figure 9.

E.9.6.3 Semi-volatile Compounds

The only SVOC compound detected at a concentration that exceeded the MCL was bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate was previously detected in 6 of the 30 saprolite groundwater samples analyzed, 5 of the 8 shallow bedrock monitoring well samples, and 5 of the 6 bedrock monitoring well samples. The Phase IV supplemental groundwater sampling event detected bis(2-ethylhexyl)phthalate in only 1 of the 14 wells sampled for SVOCs.

Saprolite Interval

During prior sampling events, the presence of bis(2-ethylhexyl)phthalate at concentrations that exceeded the MCL in the saprolite was limited to the immediate vicinities of monitoring wells MW-20 west of the west property boundary and MW-15 in the northeast corner of the Site. The maximum concentrations of bis(2-ethylhexyl)phthalate previously reported at MW-20 and MW-15 are 9.6 micrograms per liter ($\mu\text{g/L}$) and 8.6 $\mu\text{g/L}$, respectively. These concentrations only slightly exceed the MCL of 6 $\mu\text{g/L}$. The concentrations of bis(2-ethylhexyl)phthalate reported in duplicate samples collected from monitoring well MW-23 in 1998 were reported as 22 $\mu\text{g/L}$ and 490 $\mu\text{g/L}$. These duplicate data are not within an acceptable range for data validation purposes and the monitoring well was subsequently re-sampled on April 20, 2000. Duplicate samples collected on April 20, 2000 from monitoring well MW-23 were both reported as non-detect (with a detection limit of 10 $\mu\text{g/L}$). In the recent (December 2001) groundwater sample from MW-23, bis(2-ethylhexyl)phthalate was reported as non-detect. Consequently, the elevated concentration reported in 1998 (i.e. 490 $\mu\text{g/L}$) is not considered valid based on duplicate data and recent sampling results.

Bis(2-ethylhexyl)phthalate was not detected in the background monitoring well (MW-14), TW-2 or in TW-1, downgradient of well MW-20, during previous groundwater investigations. Monitoring well MW-20 is also hydraulically upgradient of the landfill area and is located approximately 800 feet south of MW-14. Bis(2-ethylhexyl)phthalate was previously detected in the sample from MW-20 at a concentration of 9.6 $\mu\text{g/L}$ that slightly exceeded the MCL but not in the re-sample of MW-20 (at a detection limit of 10 $\mu\text{g/L}$). Bis(2-ethylhexyl)phthalate was not detected at elevated concentrations in the surface soil samples collected from the vicinity of MW-20. The presence of bis(2-ethylhexyl)phthalate in MW-20, while absent from MW-14 and from surface soils in the area, is not explained.

Shallow Bedrock Interval

Previous investigations reported that the concentrations of bis(2-ethylhexyl)phthalate in the shallow bedrock monitoring wells were generally higher than in the saprolite wells, with detected concentrations ranging from 7.4 $\mu\text{g/L}$ at MW-9A to 44 $\mu\text{g/L}$ at MW-10A. With

the exception of MW-8A and MW-13 in which it was not detected, bis(2-ethylhexyl)phthalate previously was reported in all shallow bedrock groundwater samples at concentrations that exceeded the MCL.

The highest concentration of bis(2-ethylhexyl)phthalate (44 $\mu\text{g/L}$) was detected at MW-10A, downgradient of the landfill area. Bis(2-ethylhexyl)phthalate was not detected in the saprolite monitoring well at this location and no elevated concentrations of bis(2-ethylhexyl)phthalate were detected in surface soils in the vicinity of this well.

For the shallow bedrock wells that were sampled and analyzed for SVOCs during the Phase

IV supplemental RI groundwater sampling event, all samples, including the newly installed wells MW- 23A and MW- 24A south of Maple Creek, reported bis(2- ethylhexyl)phthalate as non-detect (samples from shallow bedrock wells MW-13 and TW-5 were not analyzed for SVOCs; shallow bedrock well MW-18A was dry).

Bedrock Interval

The concentrations of bis(2-ethylhexyl)phthalate in the bedrock interval monitoring wells ranged from 3 µg/L to 25 µg/L, in previous investigations. Previously, the highest concentration, 25 µg/L, was detected in monitoring well MW- 9B, located hydraulically down gradient of the potential surface soil source areas. However, samples collected from MW-9B during the Phase IV investigation were reported as non-detect for bis(2-ethylhexyl)phthalate.

Bis(2- ethylhexyl)phthalate was previously detected at a concentration greater than the MCL in well MW-6A on one occasion. This well is south southwest of MW-9B and is, therefore, further down gradient from MW-9B. In addition, bis(2-ethylhexyl)phthalate was reported above the MCL in MW-4A, MW-11A and MW- 16A in prior investigations. Of the bedrock wells sampled during the Phase IV groundwater investigation, only one well (MW-16A) contained bis(2-ethylhexyl)phthalate (11 µg/L) in exceedance (marginally) of the compound's MCL.

E.9.6.4 Pesticides

Groundwater samples were not analyzed for pesticides during the Phase IV groundwater sampling event.

In previous investigations, pesticides were detected in two saprolite monitoring wells, MW- 8 and MW-24. No pesticides were detected in either the shallow bedrock or bedrock monitoring intervals. The pesticides detected were alpha BHC, dieldrin, and heptachlor epoxide in MW-8 and aldrin, dieldrin, and endrin in MW-24. Only one compound, heptachlor epoxide in MW- 8, was present at a concentration that exceeded the MCL. The concentration of heptachlor epoxide in MW- 8 was 0.92 µg/L versus the MCL of 0.2 µg/L. Dieldrin was the only pesticide detected in both MW- 8 and MW-24. EPA has not developed an MCL for dieldrin; both reported concentrations exceed the EPA Region 9 PRG's for residential tap water (0.0042 µg/L).

No pesticides were detected in the background saprolite monitoring well (MW-14). None of the pesticides detected in the groundwater sample from MW- 8 were detected in the surface soil samples from the surrounding areas. Nonetheless, given the location of MW- 8 and the shallow nature of the pesticide presence, the presence of the pesticides in MW- 8 may be a result of Site activities. However, the concentrations detected are very low and the extent of pesticide presence is limited to the saprolite interval in the immediate vicinity of MW- 8. The detection of pesticides in MW-24, which is located on the south side of Maple Creek

opposite the southwest quadrant of the Site, is unexplained. As stated previously, saprolite groundwater discharges into Maple Creek upgradient of MW-24 and, therefore, Site impacted groundwater from this interval is not expected to be present on the south side of Maple Creek. In addition, pesticides are not present in the saprolite monitoring well MW-10 or shallow bedrock monitoring well MW-13, which are immediately upgradient of MW-24. Therefore, the presence of pesticides in this well does not appear to be related to Site activities.

E.9.6.5 Volatile Organic Compounds

In previous investigations, several VOCs were detected in the groundwater samples. However, the only VOCs present at concentrations that exceeded their respective MCLs were 1,1-dichloroethene, 1,2-dichloroethane, 1,2-dichloroethene (total), benzene, tetrachloroethene, trichloroethene, and vinyl chloride. The exceedance of the MCL for 1,2-dichloroethane occurred only in saprolite monitoring well MW- 3. Exceedances of the MCL for benzene occurred in MW- 3 and saprolite monitoring well MW- 7. No exceedances of the VOC MCLs occurred in any monitoring well installed south of Maple Creek or in the DPT samples with the exception of tetrachloroethene in the groundwater sample from DP-04, which marginally exceeded the MCL at a concentration of 5.4 µg/L.

PCE and TCE were detected the most frequently and in all monitored intervals. With the exception of benzene and 1,2-dichloroethane, the other compounds that exceeded their MCLs and occurred in more than one or two isolated samples are degradation products of PCE/TCE. Therefore, the extent of the VOC groundwater plume is characterized in the following discussion based upon the presence of PCE and TCE. This approach is intended to simplify the definition of the groundwater contaminant plume and is not intended to diminish the importance of the presence of the other constituents. The locations at which the concentrations of the other VOCs exceeded their respective MCLs are all located within the limits of the PCE/TCE plume(s). Therefore, the definition of the PCE/TCE plumes will encompass all groundwater impacted by VOCs.

During the recent Phase IV supplemental RI groundwater sampling event, the following VOCs were detected in exceedance of their respective MCLs: benzene; cis-1,2 dichloroethene; 1,1-dichloroethene; 1,2-dichloroethane; tetrachloroethene; 1,1,1 trichloroethane; trichloroethene; and vinyl chloride. Cis-1,2-dichloroethene, tetrachloroethene, and trichloroethene were detected the most frequently and in all monitored intervals.

The analytical data for PCE and TCE in the various groundwater intervals have been plotted on Figures 26 through 31.

Saprolite Interval

All of the VOCs that were present in groundwater at concentrations that exceeded their respective MCLs were present in the saprolite interval. None of these compounds were detected in background saprolite monitoring well MW-14. Isopleths for total VOC concentrations in the saprolite interval are shown on Figure 28. Isopleths of PCE and TCE concentrations in the saprolite are presented on Figures 26 and 27 respectively.

As shown on Figure 26 and 27, the presence of PCE and TCE in Site groundwater at concentrations that exceeded their MCLs of 5 µg/L is in three areas: the Administrative Area (MW-1); the 502/503 and 601 Areas; and, southwest of the 510 Area. The highest reported concentration of PCE in 2001 was 1,200 µg/L from monitoring well MW-1 (the reported concentration in 2000 was 830 µg/L). The concentrations of PCE in MW-12 and MW-19 were 100 µg/L and 140 µg/L, respectively in 1998. The concentrations of PCE in MW-12 and MW-19 were reported as 110 µg/L and 290 µg/L, respectively in 2001. Results from the Phase IV groundwater investigation also reported levels of PCE in MW-3 and MW-10 at concentrations of 200 µg/L and 130 µg/L, respectively. The highest concentration of TCE (265 µg/L) was detected at MW-10 and the concentrations at MW-1 and MW-19 were 140 µg/L and 57 µg/L, respectively in 1998. The highest concentration of TCE (640 µg/L) was detected in MW-12; the reported concentrations at MW-10, MW-1, and MW-19 were 360 µg/L, 46 µg/L, and 33 µg/L, respectively in 2001.

MW-1 is hydraulically cross gradient of the 501-09 and Process Distillation Areas in which the highest concentrations of PCE and TCE in soil were detected. MW-9 is hydraulically downgradient from the potential source areas; however, except in sample DP-4, neither PCE nor TCE were detected in any of the soil samples collected from locations surrounding MW-19.

No VOCs were detected in the saprolite monitoring wells or the direct push sample located south of Maple Creek.

Shallow Bedrock Interval

The VOCs present at concentrations that exceeded their respective MCLs in groundwater in the shallow bedrock interval were benzene, 1,2-dichloroethane, PCE, TCE, 1,1-DCE, vinyl chloride, and 1,2-DCE. Isopleths illustrating total VOC concentrations in shallow bedrock groundwater are shown on Figure 31. Isopleths of the PCE and TCE concentrations in the shallow bedrock are presented on Figures 28 and 29, respectively. The decreases in the concentrations of PCE and TCE with depth can be seen in the profile plot of the concentration data presented on Figure 32.

Much of the PCE/TCE groundwater plume in the shallow bedrock interval centers around wells MW-7A, MW-9 and MW-11A. This area is hydraulically downgradient of the potential sources in the 509, 601, and Process Distillation Areas. Therefore, the most likely

sources of PCE/TCE in the shallow bedrock interval include soils in these potential source areas and impacted groundwater in the overlying water table interval. MW- 13 is located along the western boundary of the Site in the southwest quadrant. There are no identified potential source areas of PCE located in the vicinity of MW- 13; however, groundwater flow from the Process Distillation Area may be reflected in MW-13.

Based on the presence of upward vertical hydraulic gradients between the bedrock and saprolite over most of the Site, and the lack of VOC detections in the monitoring wells south of Maple Creek, it appears that the shallow bedrock groundwater discharges to Maple Creek.

Bedrock Interval

VOCs present at concentrations that exceeded their MCLs in groundwater in the deeper bedrock interval included benzene, 1,2-DCE, TCE, PCE, 1,1-DCE, and vinyl chloride. The concentration of PCE in the bedrock interval ranged from non-detect to 180 µg/L at MW-9B. PCE was not detected in bedrock monitoring well MW- 6A. PCE, TCE 1,1-DCE, benzene and vinyl chloride were detected in MW-11A. The concentrations of PCE and TCE in the bedrock interval have been plotted on Figures 29 and 30, respectively.

The presence of PCE at locations MW- 8B, MW-9B and MW-11A is consistent with its presence in the upper intervals and the locations of the potential source areas. Therefore, the source of PCE/TCE in bedrock interval groundwater is most likely the impacted groundwater at the shallower depths.

E.9.6.6 Metals

New wells and a sub-set of existing monitoring wells were sampled for metals in December 2001. Therefore, the assessment that follows combines recent and prior data to provide a complete overview of metal concentrations in groundwater.

During prior investigations, six of the TAL metals, aluminum, antimony, iron, lead, manganese, and thallium, were detected in groundwater from Site monitoring wells at concentrations that exceeded the MCLs. In previous investigations, thallium exceeded its MCL in only one sample from monitoring well MW-3; the only MCL exceedance for antimony was reported in monitoring well MW-11A. The MCL exceedance for lead occurred in background monitoring well MW-14 for one sampling event. During the Phase IV supplemental RI groundwater investigation, five of the TAL metals, aluminum, antimony, iron, manganese, and thallium, were detected in groundwater from Site monitoring wells at concentrations that exceeded the MCLs. The respective exceedances can be viewed in Appendix B.

Previous investigations suggest that the composition of the geologic units in which the monitoring wells are installed is essentially the same. Therefore, the background concentrations detected in saprolite monitoring well MW-14 are assumed to be also

representative of background in the other monitored intervals. Based on that assumption and the analytical data from previous investigations, the only metals that are present at concentrations that exceed both the MCLs and background concentrations are iron, manganese, and thallium.

The MCL and background concentrations of iron were exceeded in only one monitoring well, MW- 7 (95,400 µg/L), during Phase IV. Monitoring well MW-7 is a saprolite monitoring well in a well nest that includes shallow bedrock and bedrock monitoring wells. Iron was not detected at concentrations that exceeded the standards in any of the other samples from this well nest. Elevated concentrations of iron were present in the majority of surface soil samples. The concentration of iron in MW-7 may be attributable to landfill influences.

The MCL and background concentrations of thallium were exceeded in only one monitoring well, MW- 3 (14 µg/L) during the prior investigations. It was, however, reported in two of the wells sampled for metals during the Phase IV RI investigation (MW- 7, MW-9A). MW- 3 and MW-7 are saprolite monitoring wells. The source of thallium in the samples is unknown; however, the location of MW-3 is immediately adjacent to the landfill area and MW-7 is within the landfill area. The absence of thallium at similar concentrations in the background and other groundwater samples suggest that the presence of thallium in the samples from MW- 3 and MW-7 may be the result of a localized Site influence. MW-9A is a shallow bedrock well situated beneath the landfill in the vicinity of MW-3. Thallium was not detected in the shallow saprolite well at this location (MW-9). The volume of groundwater with elevated concentrations of thallium is limited to the saprolite interval in the immediate vicinity of MW- 3 and MW-7.

The exceedances of the MCL and background concentrations of manganese occurred primarily in the saprolite monitoring wells with limited exceedances occurring in the shallow bedrock (MW-8A, MW-10A, and MW-13) and bedrock (MW-11A). Manganese was not present in the bedrock interval at any concentration that exceeded the MCL and background concentrations.

The plumes of groundwater exhibiting elevated concentrations of manganese (>200 µg/L) are centered around wells MW-3 in the saprolite interval and MW-11A in the bedrock interval. These wells are located in the approximate center of the Site, west of the landfill area. The limit of the manganese plume in the saprolite interval extends across the area bounded by the landfill limit on the north and east, and by the western limits of the operational areas on the west. The plume narrows to the south and is generally within the landfill limit. Elevated concentrations of manganese were detected in monitoring well MW- 22, but not in any other monitoring well located south of Maple Creek. Manganese was non-detect in the recent groundwater sample collected from monitoring well MW-23 by low flow purging/sampling techniques suggesting previous detections may have been attributable to turbidity in the samples (Note: similar reductions were observed in MW-2, MW-14, MW-19, and MW-20). Therefore, due to the pattern of groundwater flow described previously which demonstrates that most of the saprolite groundwater discharges into Maple Creek and the absence of elevated concentrations of manganese in the other wells south of Maple Creek, the presence of an elevated concentration

of manganese in MW-22 is not considered a result of Site related activities. In addition to the manganese plume, there is an elevated concentration in MW-1 east of the east drainage ditch. This detection appears to be localized as the monitoring wells in the immediate vicinity of MW-1 (MW- 8 and MW-5) do not exhibit elevated concentrations of manganese.

Groundwater with elevated concentrations of manganese in the shallow bedrock interval is within the limit of the Site operation areas, outside the limit of the landfill. The manganese plume in the shallow bedrock extends beyond the saprolite plume in the southwest direction at MW-10A.

Manganese is readily released from soil and rock with acidic changes in the pH. Such changes in pH would be expected to be associated with the presence of the landfill and possibly the facility operations. Therefore, with the exception of MW-22, the presence of elevated concentrations of manganese in saprolite, shallow bedrock and bedrock groundwater is most likely a result of Site activities.

E.9.7 Sediment

The characterization of sediment in the drainage ditch east of the landfill area and in Maple Creek is based upon the analytical data from samples collected at eight locations (SD- 01 through SD-06, CRA-07, and CRA-08) which are located north, east, and south of the Site. Sediment sample location SD-02 is located in the ditch along the east side of the landfill area. The drainage ditch located north of the Site, which drains the property north of the Site as well as the northeast corner of the landfill area, drains into the east ditch along the northern edge of the property. Sediment sample locations SD-1, SD-3 through SD-6, CRA-07 and CRA-08 are located in Maple Creek. Sediment sample locations SD-3, CRA-07, and CRA-08 are located approximately 1,000 feet, 6,000 feet, and 1,000 feet upstream of the Site, respectively, and represent background conditions. To evaluate the impact of Site surface water runoff and groundwater discharge on the quality of the sediments in Maple Creek, the analytical data from the sample locations within the area of influence of the Site have been compared to background. The concentrations of the compounds detected in the sediment samples are presented in Appendix B and are illustrated on Figures 33 and 34. Potential impacts to the creek and sediments attributable to the recent installation of a sanitary sewer trunk main along, adjacent to, and across the creek in several locations are not known. The organic chemical compounds detected in the sediment samples were SVOCs and VOCs. Various SVOC and VOC compounds were detected in the samples collected from Maple Creek. However, none of the concentrations were higher than the compounds' respective PRGs. Only two compounds detected at location SD-1 downstream of the Site, benzo(b)fluoranthene and benzo(k)fluoranthene, were not detected at location SD-3 which is upstream of the Site and reflective of background. Benzo(b)fluoranthene and benzo(k)fluoranthene were detected at SD-1 at estimated concentrations of 66 and 74 µg/kg, respectively. These compounds were also detected at SD-5 at estimated concentrations of 160 and 140 µg/kg; however, each was detected in only one Site surface soil sample and neither was detected in any groundwater sample. There is no obvious on-site source of these

compounds to the sediment of Maple Creek; however, similarly to Aroclor 1248 and 2-methylnaphthalene, the most likely source is Site surface soil. The concentrations of the other compounds detected at SD-1, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, phenanthrene, and pyrene, were approximately the same as the concentrations at background location SD-3. Therefore, the presence of these compounds has not been influenced by the Site condition. All metals analytes were detected in the sediment samples. Chromium, mercury, and silver were detected in sediment samples at concentrations which exceeded their respective PRGs. In the evaluation of the sediment metals data, the same convention utilized in the evaluation of the soil analytical data has been applied: detected concentrations are first compared to the PRG and, if higher than the PRG, are then compared to the estimated maximum background concentration. The estimated maximum background concentrations are equal to two times the average concentration detected in the background samples.

Chromium was detected at concentrations which exceeded its PRG in all sediment samples, including the background samples. The comparison of the exceedances to the maximum estimated background concentration (two times background) of 17.4 mg/kg indicates the samples collected at SD-1, SD-2, SD-5 (June 1990), and SD-6 exceeded both background and the PRG. The average concentration of chromium in the sediment sample from location SD-5 located in Maple Creek was 20.9 mg/kg, only slightly higher than the estimated maximum background concentration and is most likely reflective of background conditions and not of an influence from the Site. The concentrations of chromium in samples collected from the other locations in Maple Creek ranged from 13.5 mg/kg at SD-6 to 23.7 mg/kg at SD-1 downstream of the Site. Chromium was detected in all surface soil samples. The concentrations of chromium in the Site - surface soil samples ranged from 4.6 mg/kg to 339 mg/kg with an average concentration of 78.4 mg/kg and the concentrations in the 0 to 1-foot bgs samples from the off-Site borings ranged from 19 mg/kg to 34.9 mg/kg with an average concentration of 31.2 mg/kg. The highest concentrations of chromium were generally detected in the surface soil samples from the 501, 509, and Sedimentation Basin Areas. Areas 501 and 509 have potential to impact the sediments in the vicinity of SD-2 through transport of soil particles in surface water runoff. Therefore, the probable source of chromium at SD-2 is surface water runoff from the 501 and 509 areas. Mercury was detected in the sample from one location (SD-5) at concentrations which exceeded the PRG of 0.15 mg/kg. This concentration was also higher than the estimated maximum background concentration of 0.12 mg/kg. Mercury was detected in 51 of the 78 Site surface soil samples at concentrations which ranged from 0.12 mg/kg to 72.6 mg/kg and averaged 3.6 mg/kg. Mercury was not detected in the off-Site borings at any concentration greater than 0.21 mg/kg. The highest concentrations of mercury in Site surface soil were in the samples from Area 501, specifically Areas 501-01, 501-03, Area 501-04, and 501-06. The concentrations in these areas ranged from 15.1 mg/kg to 62.9 mg/kg.

Nickel was detected in the sample from one location at concentrations which exceeded the PRG of 20.9 mg/kg. The location at which the exceedance occurred is located in the drainage ditch in one of the samples collected at SD-2 (25 mg/kg in June 1998). A confirmatory

sample was collected at SD-2 in July 1999. The concentration of nickel in this sample was 13 mg/kg, less than the PRG. Both these concentrations are higher than the estimated background concentration of 4.8 mg/kg. Nickel was detected in 67 of the 78 Site surface soil samples at concentrations which ranged from 2.5 mg/kg to 1,180 mg/kg. The average concentration in Site surface soils was 36.4 mg/kg.

E.9.8 Surface Water

The characterization of surface water in the drainage ditch east of the landfill area and in Maple Creek is based upon the analytical data from samples collected at six locations (SW-1 through SW-6) which are located north, east, and south of the Site. Surface water sample location SW-2 is located in the ditch along the east side of the landfill area. The drainage ditch located upgradient (north) of the Site, which drains the off-site property north of the Site as well as the northeast corner of the landfill area, drains into the east ditch. The data from SW-2, therefore, represent potential contributions from the Site and from the off-site properties to the north. Surface water sample locations SW-1, SW-3 through SW-6, CRA-07, and CRA-08 are located in Maple Creek. Surface water locations SW-3, CRA-07, and CRA-08 are located approximately 1,000 feet, 6,000 feet, and 1,000 feet upstream of the Site, respectively and represent background surface water quality. To evaluate the impact of Site surface water runoff and groundwater discharge to the quality of the surface water in Maple Creek, the analytical data from the sample locations within the area of influence of the Site have been compared to background. The concentrations of the compounds detected in the surface water samples are presented in Appendix B, and have been mapped on Figures 33 and 34. The only organic chemical compounds detected in the surface water samples were VOCs. Six VOCs, 1,1-dichloroethane, 1,2-dichloroethene (total), benzene, tetrachloroethene, trichloroethene, and vinyl chloride, were detected; however, no concentration exceeded its PRG. No VOCs were detected in background sample SW-3. Sample locations SW-4 and SW-5 are located in Maple Creek along the south boundary of the landfill area. The influence of saprolite groundwater discharging from the landfill area into Maple Creek would be reflected in the analytical data from these locations. No VOCs were detected in the sample from location SW-4. Two VOCs, 1,2-dichloroethene (total) and trichloroethene, were detected in the sample from SW-5; however, the concentrations of each compound were less than 1 µg/L. These data demonstrate that groundwater discharge into Maple Creek has had no significant effect on the quality of surface water in the creek adjacent to the Site.

All six of the VOCs noted above were detected at location SW-2 in the eastern drainage ditch; however, none of the concentrations exceeded the PRG. The presence of these compounds in surface water at this location is most likely a result of the discharge of saprolite- groundwater into the ditch. Sample locations SW-6 and SW-1 are located in Maple Creek downstream of the discharge point of the east drainage ditch into the creek. Three VOCs, 1,2-dichloroethene (total), tetrachloroethene, and trichloroethene, were detected in the samples from these locations. The concentrations of the VOCs detected in the samples

from locations SW-6 and SW-1 were low, ranging from 0.43 µg/L to 2 µg/L. All these concentrations are orders of magnitude below the PRGs. These data demonstrate that the VOCs detected in the samples from Maple Creek may be present as a result of Site influence, however, there has been no significant effect on the water quality of the creek. All metals analytes were detected in the surface water samples. The concentrations of aluminum, iron, and manganese in all samples exceeded the PRGs; however, only manganese in SW-2 is present at concentrations which exceeded both the PRGs and two times the average background concentrations. As described in the previous section, the influence of saprolite groundwater discharging from the landfill area into Maple Creek would be reflected in the analytical data from sample locations SW-4 and SW-5. The concentrations of the metals which exceeded the PRGs at these locations were not higher than the maximum background concentrations. These data further demonstrate that groundwater discharge into Maple Creek has had no significant effect on the quality of surface water in the creek adjacent to the Site. The concentrations of iron and manganese in the sample from the east ditch (SW-2) are higher than in any other sample, averaging 1,890 µg/L and 4,150 µg/L, respectively. The presence of these metals at these concentrations in the east ditch may be reflective of saprolite groundwater discharging into the ditch. The concentrations of these analytes in the samples from Maple Creek downstream of the ditch discharge (SW-6 and SW-1) are approximately equal in both samples, iron is present at 835 µg/L at SW-6 and 876 µg/L at SW-1, and manganese is present at 63 µg/L at SW-6 and 62 µg/L, at SW-1. These concentrations exceed the PRGs but are not higher than two times the average background concentrations. If the presence of these compounds were a result of an influence from the east drainage ditch, the concentrations would be expected to decrease with distance from the ditch. This is not the pattern exhibited by these data. Additionally, the concentrations of iron and manganese at locations SW-6 and SW-1 are within the range of two times the average background concentrations and are not indicative of impact from the east drainage ditch on the Site. Aluminum is present at an average concentration of 1,035 µg/L at SW-6. This concentration exceeds the PRG; however, it is essentially equal to the average background concentration of 1,033 µg/L. Aluminum was not detected at a concentration which was higher than background in any surface water sample collected from locations adjacent to the Site. Therefore, the presence of aluminum at SW-6 is reflective of the range of background concentrations and not an impact of the Site. The surface water and sediment analytical data demonstrate that the Site and adjacent properties to the north may have impacted the quality of sediments and surface water in the east drainage ditch. However, there are no concentrations of organic chemical compounds or metals in the sediment or surface water of Maple Creek which exceeded the higher of background or screening criteria. Therefore, there has been no significant impact on the sediments or surface water of Maple Creek from Site activities.

E.10 Contaminant Fate and Transport

The evaluation of all available Site data identified four potentially significant migration pathways: landfill gas emissions to ambient air; leaching of contaminants from soil to

groundwater; migration of groundwater to surface water; and, vapor transport from groundwater to indoor air.

- A landfill gas assessment was conducted to estimate maximum landfill gas emission rates and exposure point concentrations. Comparison of the predicted maximum emission rates to South Carolina's de minimis emission criteria showed that only benzene and vinyl chloride exceeded the criteria. Based on the results of the air dispersion model, the resulting 24 hour average concentrations are below South Carolina Maximum Ambient Air Concentrations (MAACs). Therefore, landfill gas emissions do not pose a significant risk to on-Site or off-site receptors.
- A qualitative assessment of the potential for leaching of contaminants from soil to groundwater identified a limited potential for groundwater impact. Residual soil primarily contaminated with VOCs is generally limited to the upper 4 feet of the soil horizon.
- The evaluation of groundwater migration to surface water has shown that the closure of the landfill, and the Removal Action has resulted in the general decline of contaminant concentrations in the groundwater across the Site. Groundwater discharges to Maple Creek over most of the Site. However, this discharge of groundwater to Maple Creek has not resulted in an unacceptable impact on the surface water quality and is not expected to impact surface water quality.
- An evaluation of the potential migration of VOC vapors from the groundwater to indoor air was undertaken for the former Administration Area. This evaluation used the an air modeling program, and assumed conservatively future residential development even though such development is currently prohibited at the Site. The results of this evaluation indicated that the potential vapor migration from groundwater would not result in an unacceptable risk.

F. CURRENT AND POTENTIAL FUTURE LAND AND WATER USES

F.1 Land Uses

The Site is presently undeveloped and the land surrounding the Site is generally wooded, with the closest residences located approximately 650 feet to the east. Although no activities of a commercial nature are currently being conducted at the Site, the property is zoned as commercial/industrial, consistent with planned future development in the area. Further, the Site is located within the "Airport Environs Area" as defined by the Greenville - Spartanburg Airport Environs Area zoning ordinance, dated March 29, 1996. This zoning ordinance precludes future residential development and use of the Site. Most likely, workers may conduct occupational, construction or maintenance/installation activities at the Site in the

future.

F.2 Groundwater Uses

Groundwater is not in use at the Site, but one nearby water well within 1/4-mile is in use for non-potable uses such as irrigating lawns and gardens, and washing cars. This resident is also connected to a municipal water system. Although, the vast majority of the nearby water use is supplied by a municipal water system, SCDHEC groundwater classifications for the area indicate that groundwater from the aquifer system is considered a current and potential future source of drinking water.

F.3 Surface Water Uses

Under South Carolina Code of Regulations, Water Classifications and Standards (Regulations 61-68) and Classified Waters (Regulation 61-69), Maple Creek is classified as a Freshwater water body. However, the area of Maple Creek immediately adjacent to the Site does not appear to be used for recreational activities.

G. SUMMARY OF SITE RISKS

G.1 Summary of Human Health Risk Assessment

The Human Health Baseline Risk Assessment (BRA) estimates what risks the Site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the BRA for this Site.

The BRA for the Aqua-Tech Site addressed two Exposure Units. Exposure Unit 1 (EU-1) is defined to include the area inside the existing security fence and extending to the drainage ditch just beyond the southeast extent of the closed MSWL, as shown on Figure 35. Exposure Unit 2 (EU-2) is defined to include all other areas of the Site (i.e., outside the fence and beyond the drainage ditch on the south and east of the Site). The data used to calculate risks for each exposure unit are presented in Appendix B. Specifically, the BRA addressed the potential for exposure to the various environmental media located at the Site, and at Maple Creek, or based upon off-site air emissions. These environmental media included surface soil, air, subsurface soil and groundwater in EU-1 and EU2 (because of the mobile nature of groundwater the exposure units were combined for this medium). Sediment and surface water were assessed in EU-2. For each environmental medium, Tables 1.1 - 1.6 (included in Appendix C) provide the appropriate scenarios, exposure points, receptor populations and exposure routes, as well as the rationale for selection or exclusion of each exposure pathway for the Site. A summary of exposure pathways evaluated quantitatively is provided below.

Table 2 - Summary of Exposure Pathways Evaluated Qualitatively

Environmental Medium	Scenario Timeframe	Receptor Population
Surface Soil	Current	Adolescent Trespasser/Visitor (EU-1/EU-2)
Surface Soil	Future	Resident (EU-1/EU-2) Commercial Worker (EU-1/EU-2) Construction Worker (EU-1/EU-2)
Subsurface Soil	Current	None
Subsurface Soil	Future	Construction Worker (EU-1/EU-2)
Sediment	Current	Adolescent Trespasser/Visitor (EU-2)
Sediment	Future	Construction Worker (EU-2)
Groundwater	Current	None (qualitative only)
Groundwater	Future	Irrigation/Maintenance Worker (EU-1/EU-2) Resident (EU-1/EU-2)
Surface Water	Current	Adolescent Trespasser/Visitor (EU-2)
Surface Water	Future	None (qualitative only , same as current)
Air	Current	Adolescent Trespasser/Visitor (EU-1/EU-2)
Air	Future	Resident (EU-1/EU-2) Commercial Worker (EU-1/EU-2) Construction Worker (EU-1/EU-2) Irrigation /Maintenance Worker (EU-1/EU-2)

Although, the residential scenario was included for completeness of the BRA, future residential use of the Site and its environs is prohibited by the applicable zoning ordinance related to the proximity of the Site to the Greenville-Spartanburg Airport. Furthermore, the clean-up levels for all media of concern at the Site excluding groundwater will be based on future commercial/industrial use (1×10^{-6} for carcinogenic compounds and HQ of 1 for non-carcinogenic compounds). Since SCDHEC classifies the shallow groundwater beneath the Site as a potential source of drinking water, the clean-up levels for groundwater will be based on future residential use.

While the EPA Presumptive Remedy Guidance allows for streamlining the BRA, the presence of numerous environmental media (soil, groundwater, surface water, sediment and landfill gas) and several routes of exposure (dermal, ingestion and inhalation) led to the generation of a full quantitative assessment.

G.1.1 Conceptual Site Model

The Conceptual Site Model developed in the BRA is presented in Table 3.

Table 3 - Conceptual Site Model For the BRA (*Exposure Scenarios Evaluated Quantitatively*)

Scenario	Receptor	Exposure Pathway(s)	Exposure Routes
EPS - 1 Current Use	Adolescent Trespasser/Site Visitor (EU-1/EU-2)	Surface Soil Sediment ¹ Surface Water ¹ Air	Incidental Ingestion Dermal Contact Inhalation of Particulates ² Inhalation of Volatiles ²
EPS - 2 Future Use	Child and Adult Resident (EU-1/EU-2)	Surface Soil Groundwater Air	Incidental Ingestion Dermal Contact Inhalation of Particulates ² Inhalation of Volatiles ²
EPS - 3 Future Use	Commercial Worker (EU-1/EU-2)	Surface Soil Air	Incidental Ingestion Dermal Contact Inhalation of Particulates ² Inhalation of Volatiles ²
EPS - 4 Future Use	Construction Worker (EU-1/EU-2)	Surface Soil Subsurface Soil Sediment ¹ Air	Incidental Ingestion Dermal Contact Inhalation of Particulates ² Inhalation of Volatiles ²
EPS - 5 Future Use	Irrigation Worker (EU-1/EU-2)	Groundwater Air	Incidental Ingestion Dermal Contact Inhalation of Particulates ² Inhalation of Volatiles ²
Notes: EPS = Exposure Pathway Scenario ¹ Exposure Pathways Surface Water and Sediment are only located in EU-2 ² The Exposure Routes for the Exposure Pathway Air are Inhalation of Particulates ² and Inhalation of Volatiles ²			

G.1.2 Identification of Chemicals of Concern

As described in section G.1, the BRA evaluated soil, surface water, sediment, groundwater and air. Only the surface soil, subsurface soil, groundwater and air media were found to have Chemicals of Concern (COCs). Those COCs, their frequency of detection, range of concentrations, and exposure point concentrations are found in Tables 4, 5 and 6.

Table 4 - BRA COCs - Surface Soil

		Frequency of Detection	Range of Detection Concentrations (mg/kg)	Exposure Point Concentration(mg/kg)
Iron	EU1	69/69	8,080 - 56,300	45,866
	EU2	11/11	9,700 - 40,000	27,800
Lead	EU1	69/69	14.3 - 1,290	98
	EU2	11/11	17.3 - 55.3	----

Mercury	EU1	50/69	0.13 - 73	7.3
	EU2	2/11	0.12-.51	----

Table 4a - BRA COCs - Subsurface Soil

		Frequency of Detection	Range of Detection Concentrations (mg/kg)	Exposure Point Concentration(mg/kg)
Aroclor 1242	EU1	3/16	0.07 - 19	4.0
	EU2	-----	-----	----
Iron	EU1	21/21	24,800 - 63,000	43,800
	EU2	-----	27,300 - 41,000	-----
Thallium	EU1	10/21	0.84 - 343	12
	EU2	1/21	1.7	Not Calculated
Trichloroethene	EU1	23/85	.0029 - 1,020	50
	EU2	-----	-----	----

Table 5 - BRA COC - Air

	Frequency of Detection	Range of Detection Concentrations (mg/kg)	Maximum Concentration (mg/m³)	Exposure Point Concentration(mg/kg)
Benzene	Not Applicable	Not Applicable	.0007176	.0007176

Table 6 - BRA COCs - Groundwater

	Frequency of Detection	Range of Detection Concentrations (mg/L)	Exposure Point Concentration(mg/L)
1,1,2,2-Tetrachloroethane	8/47	.0026 - 0.036	0.015
1,1-Dichloroethene	7/47	.0043 - 0.094	0.018
Benzene	11/47	.00023- 0.054	0.021
cis-1,2-Dichloroethene	27/47	.00094 - 0.97	0.41
Tetrachloroethene	32/47	.00037 - 1.2	0.11
Trichloroethene	26/47	.00028 - 0.64	0.33
Vinyl Chloride	8/47	.00022 - 0.084	0.031

G.1.3 Exposure Assessment

There were five potentially exposed populations evaluated in the BRA. The five Exposure Pathway Scenarios (EPS) evaluated included Current Adolescent Trespasser/Site Visitor (EPS - 1), Future Child and Adult Resident (EPS-2), Future Commercial Worker(EPS-3), Future Construction Worker (EPS-4) and Future Irrigation Worker (EPS-5). The exposure pathways quantitatively evaluated can be found in the Conceptual Site Model developed for the BRA in Section G.1.1 in this ROD. The exposure assumptions used for the major exposure pathways for each scenario are summarized in Table 7.

Table 7 - Exposure Assumptions

	EPS - 1 Current Adolescent Trespasser/S ite Visitor	EPS - 2 Future Child	EPS - 2 Future Adult Resident	EPS - 3 Future Commercial Worker	EPS - 4 Future Construction Worker	EPS - 5 Future Irrigation Worker
Soil Ingestion Rate	100 mg/day	200 mg/day	100 mg/day	50 mg/day	195 mg/day	-----
Water Ingestion Rate	-----	1.0 L/day 1.8 L/day ¹	2 L/day	-----	-----	.02 L/day
Skin Surface Area available for contact	3,293 cm ²	1,720 cm ²	4,508 cm ²	2,503 cm ²	5000 cm ²	5,000 cm ²
Adherence Factor	.2mg/cm ² /day	.2 mg/cm ² /day	.2 mg/cm ² /day	.3 mg/cm ² /day	.5 mg/cm ² /day	-----
Particulate Emission Factor	2.33 x 10 ¹¹ m ³ /kg	2.33 x 10 ¹¹ m ³ /kg	2.33 x 10 ¹¹ m ³ /kg	2.33 x 10 ¹¹ m ³ /kg	1.17 x 10 ¹¹ m ³ /kg	2.33 x 10 ¹¹ m ³ /kg
Inhalation Rate	13 m ³ /day	8.1 m ³ /day	13.25 m ³ /day	12.8 m ³ /day	20 m ³ /day	20 m ³ /day
Exposure (EU-1) Frequency (EU-2)	50 days/yr 100 days/yr	350 days/yr	350 days/yr	250 days/yr	250 days/yr	32 days/yr
Exposure Duration	10 years	6 years	24 years	25 years	0.33 years	25 years
Body Weight	45 kg	15 kg	70 kg	70 kg	70 kg	70 kg
Averaging (NC) Time (C)	3,650 days 25,550 days	2,190 days -----	8,760 days -----	9,125 days 25,550 days	122 days 25,550 days	9,125 days 25,550 days
Dermal Absorption Factor	Chemical Specific. If not available, 0.01 for organic compounds, 0.001 for inorganic compounds.					
EU - Exposure Unit NC - Non-cancer risk C - Cancer risk						
¹ Water Ingestion Rate for the Aggregate Adult						

G.1.4 Toxicity Assessment

The BRA utilized information from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), National Center for Environmental Assessment (NCEA), Department of Energy (DOE), and the benzo(a)pyrene Toxicity Equivalence Factor (TEF) methodology. The assessment looked at both carcinogenic and non-carcinogenic effects. Table 8 provides non-carcinogenic risk information which is relevant to the primary contaminants of concern in air, soil and groundwater. Table 9 provides carcinogenic risk information which is relevant to the primary contaminants of concern in air, soil and groundwater. The oral and dermal toxicological values for noncarcinogenic COPCs (e.g., reference doses, or RfDs) are shown in Table 5.1 in Appendix C. The inhalation toxicological values for noncarcinogenic COPCs are shown in Table 5.2 in Appendix C. The toxicological values for potentially carcinogenic COPCs (e.g., carcinogenic slope factors, CSFs) are shown in Table 6.1 in Appendix C. The inhalation toxicological values for potentially carcinogenic COPCs are shown in Table 6.2 in Appendix C.

Table 8 - Non-Cancer Toxicity Data Summary for the Primary Chemicals of Concern

Exposure Pathway: Ingestion, Inhalation and Dermal							
Chemical of Concern	Chronic/ Subchronic	Oral RFD Value (mg/kg/day)	Dermal RFD Value (mg/kg/day)	Primary Target Organ	Combined Uncertainty /Modifying factors	Source	Dates of RFD: Target Organ
Aroclor 1242	Chronic Subchronic	2.0 x 10 ⁻⁵ (1) 5.0 x 10 ⁻⁵ (1)	1.7 x 10 ⁻⁵ 4.3 x 10 ⁻⁵	immunologic	300(1)	Surrogate	NA
Benzene	Chronic Subchronic	3.0 x 10 ⁻³ NF	2.7 x 10 ⁻³ NF	CNS Blood	NF	NCEA DOE	April 2002 May 2002
Dichloroethene, 1,1-	Chronic Subchronic	9.0 x 10 ⁻³ N F	9.0 x 10 ⁻³ NF	CNS Liver	1,000	IRIS IRIS	May 2002 May 2002
Dichloroethene, 1,2-(cis)	Chronic Subchronic	1.0 x 10 ⁻² 1.0 x 10 ⁻¹	8.0 x 10 ⁻³ 8.0 x 10 ⁻²	Blood	1,000	Heast Heast	1997 1997
Lead	Chronic Subchronic	NF NF	NF NF	NF	NF	NF	NA
Mercury	Chronic Subchronic	3.0 x 10 ⁻⁴ (1) NF	3.0 x 10 ⁻⁵ NF	Development CNS	1,000(1)	Surrogate	NA
Tetrachlorothane 1,1,2,2-	Chronic Subchronic	6.0 x 10 ⁻² NF	4.8 x 10 ⁻² NF	NF	NF	NCEA	April 2002
Teterachloroethene	Chronic Subchronic	1.0 x 10 ⁻² 1.0 x 10 ⁻¹	1.0 x 10 ⁻² 1.0 x 10 ⁻¹	CNS Liver	1,000	IRIS IRIS	May 2002 May 2002
Thallium	Chronic Subchronic	7.0 x 10 ⁻⁵ (1) NF	1.4 x 10 ⁻⁵ NF	CNS	NF	NCEA	April 2002
Trichloroethene	Chronic Subchronic	3.0 x 10 ⁻⁴ NF	2.8 x 10 ⁻⁴ NF	CNS Kidney	NF	NCEA	April 2002
Vinyl Chloride (adult lifetime)	Chronic Subchronic	3.0 x 10 ⁻³ NF	2.6 x 10 ⁻³ NF	CNS	NF	IRIS IRIS	May 2002 May 2002
Vinyl Chloride (entire lifetime)	Chronic Subchronic	3.0 x 10 ⁻³ NF	2.6 x 10 ⁻³ NF	CNS	NF	IRIS IRIS	May 2002 May 2002
(1) Surrogate values based on closely related compounds as follows: Aroclor 1254 for Aroclor 1242 and Aroclor 1248 Mercuric chloride for Mercury Thallic oxide for Thallium				CNS = Central Nervous System IRIS = Integrated Risk Information System DOE = Department of Energy (website) HEAST = Health Effects Assessment Summary Tables NCEA = National Center for Environmental Assessment			
NF - Not Found							

Table 9 - Cancer Toxicity Data Summary for the Primary Chemicals of Concern

Exposure Pathway: Ingestion, Inhalation and Dermal						
Chemical of Concern	Oral Cancer Slope Factor (mg/kg-day) ⁻¹	Dermal Cancer Slope Factor (mg/kg-day) ⁻¹	Inhalation Cancer Slope Factor (mg/kg-day) ⁻¹	Cancer Guideline Description	Source	Date
Aroclor 1242	2.0	2.4	4.0 x 10 ⁻¹ (1)	B2	IRIS	May 2002
Benzene	5.5 x 10 ⁻²	6.1 x 10 ⁻²	2.7 x 10 ⁻²	A	IRIS	May 2002
Dichloroethene, 1,1-	6.0 x 10 ⁻¹	6.0 x 10 ⁻¹	1.75 x 10 ⁻¹	C	IRIS	May 2002
Dichloroethene, 1,2-(cis)	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA
Tetrachloroethane 1,1,2,2-	2.0 x 10 ⁻¹	2.5 x 10 ⁻¹	2.0 x 10 ⁻¹	C	IRIS	May 2002
Tetrachloroethene	5.2 x 10 ⁻²	5.2 x 10 ⁻²	1.0 x 10 ⁻²	NF	NCEA	April 2002
Thallium	NA	NA	NA	NA	NA	NA
Trichloroethene	4.0 x 10 ⁻¹	4.2 x 10 ⁻¹	4.0 x 10 ⁻¹	B1	NECA	April 2002
Vinyl Chloride	1.5	1.7	3.1 x 10 ⁻²	A	IRIS	May 2002
<p>(1) The noted values are based on the following surrogates: Mixed PCBs for Aroclor 1242, 1248 and 1254 Mixed 2,4- and 2,6- Dinitrotoluene for 2,4 NA - Not Available IRIS = Integrated Risk Information System HEAST= Health Effects Assessment Summary Tables NCEA = National Center for Environmental Assessment TEF = Benzo(a)pyrene Toxicity Equivalence Factor methodology</p> <p>EPA Group A - Human carcinogen B1 - Probable human carcinogen - indicates that limited human data are available B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans C - Possible human carcinogen</p>						

G.1.5 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where: risk = a unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

SF = slope factor, expressed as (mg/kg-day)⁻¹.

These risks are probabilities that usually are expressed in scientific notation (*e.g.*, 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an “excess lifetime cancer risk” because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6} .

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (*e.g.*, life-time) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An $HQ < 1$ indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (*e.g.*, liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An $HI < 1$ indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An $HI > 1$ indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$\text{Non-cancer HQ} = \text{CDI/RfD}$$

where:

CDI = Chronic daily intake (mg/kg-day)

RfD = reference dose (mg/kg-day)

CDI and RfD are expressed in the same units and represent the same exposure period (*i.e.*, chronic, subchronic, or short-term).

Risks that exceed a Hazard Index of 1 or a carcinogenic risk of 1×10^{-6} are presented in Tables 10 & 11. This table *only* includes a sum of the primary COCs for the Site. This *does not* include the total risks for each receptor population or for all constituents contributing to the risks. The carcinogenic risks for the Future Aggregate Resident, Future Commercial Worker, and the Future Irrigation Worker are 4.7×10^{-3} , 2.2×10^{-6} and 2.0×10^{-5} , respectively. The non-carcinogenic risks for the Future Child Resident, Future Adult Resident, and the Future Construction Worker are 180/170 (EU-1/EU-2), 74/73 (EU-1/EU-2) and 3.2/1.0 (EU-1/EU-2), respectively. For a detail summary of the ‘Total Risk Across All Media and All Routes’ refer to Appendix B- RAGs Part D Tables.

Table 10 - Risk Characterization Summary - Carcinogens

Scenario Time Frame: Future Receptor Population: Construction Worker Receptor Age: Adult							
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Route Total
Surface Soil	Surface Soil	EU - 1 EU - 2	Iron	NC NC	---- ----	NC NC	NC NC
	Air	EU - 1	Mercury	---	NC	----	NC
Total Risk Across Surface Soil EU - 1 EU - 2							NC NC
Subsurface Soil	Subsurface Soil	EU - 1	Aroclor 1242	7.3x10 ⁻⁸	-----	1.1x10 ⁻⁸	8.4x10 ⁻⁸
			Iron	NC	-----	NC	NC
			Thallium	NC	-----	NC	NC
			Trichloroethene	1.8x10 ⁻⁷	-----	2.4x10 ⁻⁸	2.1x10 ⁻⁷
Total Risk Across Subsurface Soil							2.9x10⁻⁷
Landfill Gas	Air	EU - 1 EU - 2	Benzene Benzene	---- ----	1.8x10 ⁻⁷ 1.8x10 ⁻⁷	---- ----	1.8x10 ⁻⁷ 1.8x10 ⁻⁷
Total Risk Across Landfill Gas EU - 1 EU - 2							1.8x10⁻⁷ 1.8x10⁻⁷
Total Risk Across All Media and All Routes EU - 1 EU - 2							4.7x10⁻⁷ 1.8x10⁻⁷
'This table only includes a sum of the primary COCs for the Site. This does not include the total risks for each receptor population or for all constituents contributing to the risks. In addition, the carcinogenic risks for the Future Aggregate Resident, Future Commercial Worker, and the Future Irrigation Worker are 4.7 x10 ⁻³ , 2.2 x10 ⁻⁶ and 2.0 x10 ⁻⁵ , respectively. For a detail summary of the 'Total Risk Across All Media and All Routes' refer to Appendix B- RAGs Part D Tables.							NC - Not Calculated

Table 11 - Risk Characterization Summary - Non-Carcinogens

Scenario Time Frame: Future Receptor Population: Resident Receptor Age: Adult							
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Non-Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Route Total
Surface Soil	Surface Soil	EU - 1 EU - 2	Iron	0.21 0.31	---- ----	0.021 0.031	0.23 0.41
	Air	EU - 1	Mercury	---	0.7	-----	0.7
Total Risk Across Surface Soil EU - 1 EU - 2							0.93 0.41
Groundwater	Groundwater	EU -1& EU-2	1,1,2,2-Tetrachloroethane	NC	-----	NC	NC
			1,1-Dichloroethene	.056	-----	.056	.11
			Benzene	0.2	-----	0.2	.39
			cis-1,2-Dichloroethene	1.1	-----	1.1	2.2
			Tetrachloroethene	0.3	-----	0.3	0.6
			Trichloroethene	3.0	-----	3.0	6.0
			Vinyl Chloride	0.29	-----	0.29	0.57
Total Risk Across Groundwater							10.0
Landfill Gas	Air	EU -1 EU- 2	Benzene Benzene	---- ----	0.76 0.76	---- ----	0.76 0.76
Total Risk Across Landfill Gas EU - 1 EU - 2							0.76 0.76
Total Risk Across All Media and All Routes EU - 1 EU - 2							12.0 11.0
'This table only includes a sum of the primary COCs for the Site. This does not include the total risks for each receptor population or for all constituents contributing to the risks. In addition, the non-carcinogenic risks for the Future Child Resident, Future Adult Resident, and the Future Construction Worker are 180/170 (EU-1/EU-2) , 74/73 (EU-1/EU-2) and 3.2/1.0 (EU-1/EU-2) respectively. For a detail summary of the 'Total Risk Across All Media and All Routes' refer to Appendix B- RAGs Part D Tables.							

G.1.6 “Hot-Spots”

Potential hot spots for soil were identified as those locations with concentrations of the chemical of potential concern (COPC) which exceeded ten times the exposure point concentration (EPC) for that chemical and also exceeded the appropriate remedial goal (RG) for that chemical. The surface soil values were compared to residential RGs and the subsurface soil values were compared to the construction worker RGs. Potential hot spots for groundwater were identified as those locations with concentrations of the chemical of potential concern which exceeded ten times the EPC for that chemical and also exceeded the MCL or, if no MCL was established, exceeded the appropriate RG for that chemical. Therefore, the potential hot spots include the following:

-five locations for surface soil:

501-06;

501-04;

509-01;

601-02 B-1; and,

PCL-SA.

-two locations for subsurface soil:

DIS-SP; and,

DIS B-1.

-and four groundwater wells:

MW-1;

MW-7;

MW-16A; and,

MW-24.

For groundwater, it is important to note that because the EPC was calculated based on the four “plume” wells, these four wells have not been identified as hot spots. Three of the four hot spots identified for groundwater are based on aluminum (MW-16A and MW-24) and iron (MW-7). These metals may be naturally occurring constituents of Site groundwater. Potential risks that do exist would be further reduced following implementation of a Presumptive Remedy that is directed at the closed MSWL aspects of the Site. Table 12 identifies COCs and RGs applicable to soil for commercial/industrial use and exposures.

Table 12
Remedial Goals for Commercial/Industrial Use¹ For Soil

CHEMICALS OF CONCERN	EPC mg/kg	Maximum Detected Concentration mg/kg	Remedial Goals ²		Clean-up Level
			NON-CARCINOGENIC ² HI = 1	CARCINOGENIC ² RISK 1 X10 ⁻⁶	
<u>Surface Soil</u>					
Iron	45,866	56,300	137, 000 mg/kg	N/C	137, 000 mg/kg
Lead*	98	1,290	598 mg/kg	NC	598 mg/kg
Mercury	7.3	73	8.98 mg/kg	NC	9 mg/kg
<u>Sub-Surface Soil</u>					
Aroclor - 1242	4.0	19	22.8 mg/kg	45.6 mg/kg	23 mg/kg
Iron	43,800	63,300	137,000 mg/kg	NC	137,000 mg/kg
Thallium	12	343	34.5 mg/kg	NC	35 mg/kg
Trichloroethene	65	1,020	54.3 mg/kg	4.61 mg/kg	5 mg/kg

¹ Source: "Baseline Risk Assessment for the Aqua-Tech Environmental Site," by HSWMR, August 2002

² Exposure based on Construction Worker for Soils

MCL - Maximum Contaminant Levels from Summary Table 8 (Baseline Risk Assessment for Aqua-Tech (August 2002))

NC - Not Calculated. The noted analytes do not have the necessary toxicological guidance values to calculate RGOs for potential carcinogenic effects.

RG - Remedial goal from Summary Table 8 (Baseline Risk Assessment for Aqua-Tech (August 2002))

Potential Lead exposures based on the IEUBK Model Scenario -Adult and Aggregate Resident (IEUBK) = 400 Residential

Commercial Work (Adult Blood Lead Level) = 1,366 (assume pregnant female commercial worker), Construction Worker (Adult) = 598 (assume pregnant female construction worker)

COCs for groundwater will still include all parameters that exceed MCLs. However, if the exceedence occurs in groundwater beneath the landfill cover, achievement of the MCL will not be required at that location. Table 13 identifies COCs and RGs applicable to groundwater for residential use and exposures. COCs for groundwater identified in the BRA and whether they remain a COC are based on the following:

- i) if the maximum concentrations detected for a specific analyte are less than MCLs and RGOs, the analyte will not be considered a COC for the purposes of the FS (Note: where no detections were reported for an analyte but the detection limit exceeded the MCL or RG, the analyte shall be retained as a potential COC for monitoring);
- ii) if the maximum concentration for an analyte exceeded the RG but is less than the MCL, the analyte shall be retained as a potential COC for monitoring;
- iii) if the only reported MCL exceedences occurred in monitoring wells within the footprint of the landfill (future cover), the analyte shall be retained as a COC for monitoring;
- iv) if the MCL is exceeded in monitoring wells outside the footprint of the landfill, the analyte shall remain as a COC and be targeted for remediation (discrete, isolated or incidental exceedences or exceedences consistent with naturally occurring background may not require remediation but will be retained as potential COCs for monitoring).

Table 13
Remedial Goal For Residential Use COCs¹ For Groundwater

COC	EPC ug/l	Maximum Detected Concentration ug/l	Remedial Goals ²			Clean-up Level
			NON- CARCINOGENIC ² Risk HI = 1	CARCINOGENIC ² Risk 1X10 ⁻⁶	MCL	
1,1,2,2-Tetrachloroethane	15	36	NA	0.20 ug/l	2 ug/l	2 ug/l
1,1-Dichloroethene	18	94	70 ug/l	.066 ug/l	7 ug/l	7 ug/l
Benzene	21	54	23 ug/l	0.73 ug/l	5 ug/l	5 ug/l
cis-1,2-Dichloroethene	410	970	78 ug/l	—	70 ug/l	70 ug/l
Tetrachloroethene	110	1200	78 ug/l	0.77 ug/l	5 ug/l	5 ug/l
Trichloroethene	330	640	2.3 ug/l	0.10 ug/l	5 ug/l	5 ug/l
Vinyl Chloride	31	84	23 ug/l	0.027 ug/l	2 ug/l	2 ug/l
Other COCs ³						

¹ Source: "Baseline Risk Assessment for the Aqua-Tech Environmental Site," by HSWMR, August 2002

² The values presented are the lower of the child, adult or aggregate resident RGs as appropriate, calculated at an HI of 1.0 or carcinogenic target risk of 1x10⁻⁶.

³ COCs Proposed for future monitoring - Aluminum, Arsenic, Iron, Manganese and Thallium are naturally occurring metals that exceed the RGs, but are within background levels. The maximum concentration detected for each of the constituents bis(2-ethylhexyl)phthalate, 1,2-Dichloroethane, 1,4-Dichlorobenzene and Carbon Tetrachloride is marginal compared to the MCL.

MCL - Maximum Contaminant Levels from Summary Table 8 (Baseline Risk Assessment for Aqua-Tech (August 2002))

— - Non Applicable. The noted analytes were not identified as COCs for the noted receptors

RG - Remedial goal from Summary Table 8 (Baseline Risk Assessment for Aqua-Tech (August 2002))

G.1.7 Uncertainties

There are uncertainties which are inherent in the risk assessment process. The factors which may lead to either an overestimation or an underestimation of the potential adverse human health effects and associated environmental risks posed by exposures to analytes at the Aqua-Tech Site, depending on the relationship of actual conditions to the assumptions employed in the calculations, include the following:

- the analytical data presented here may not reflect actual Site conditions for all analytes at the present time. Data have been collected during several years of the Aqua-Tech Site investigation. However, concentrations in other areas are not expected to be higher than the values presented here because activities have ceased, and no new sources have been added. It is expected that the concentrations may actually overestimate the true exposure conditions now and in the future due to processes such as biodegradation and dilution which have occurred since the most recent sampling;
- Based on the estimated area of the former landfill and the average thickness of waste material, the estimated volume of waste in the former landfill area is approximately 320,000 cubic yards. This calculation likely overestimates the volume of municipal waste in the landfill since it is based on borings through deeper portions of the landfill and does not account for volume losses from side slopes around the perimeter of the landfill;
- assumptions regarding, for example, body weight, average human lifetime, and other factors were based on reasonable estimates from available sources and may not be accurate for specific individuals whose characteristics may vary from the conservative general conditions which were assumed. However, standard assumptions were employed in those cases where they were available and professional judgment was applied elsewhere;
- uncertainties associated with the assumptions have been made regarding the future land use and groundwater use at the Aqua-Tech Site; This may under or overestimate the risks;
- factors which affect the disposition of absorbed Site contaminants, such as metabolism, distribution, bioconcentration and excretion, were not explicitly considered in detail in the intake and risk calculations. Rather, reasonable and conservative assumptions were employed which are unlikely to underestimate the true exposure conditions. Corrections regarding route-of-exposure were made to reflect such conditions;
- the mechanism of action for toxicity of the Site contaminants is not taken into account, and is not known with certainty in many cases, particularly regarding their putative carcinogenic effects. The rather specific nature of the carcinogenic effects in animal studies suggests that any extrapolation to humans will be heavily dependent on the assumption of equivalent response in man, an assumption which often is not supported by the epidemiological data. Extrapolation of dose-response curves from high to low dose, from animals to humans and from one exposure route to another introduce uncertainty, albeit in ways which are intended to be conservative, at each step in the calculated results. This uncertainty is reflected in the recent reevaluation of U.S. EPA approaches to carcinogen assessment (U.S. EPA, 1996b). The use in this document of established Unit Cancer Risk values (i.e., Carcinogenic Slope

Factors) which have been calculated by conservative methods (e.g., the linearized multistage model) is unlikely to underestimate the true risk and may overestimate it by a margin which is not quantifiable at present; and,

- consistent with standard risk assessment practice, the U.S. EPA Reference Doses (RfDs) and Carcinogenic Slope Factors (CSFs) were used to reflect toxicity endpoints of interest; and, the intake and risk calculations assume that the exposure conditions can be represented by a deterministic approach which views each variable separately and may result in inappropriate targets because conservative assumptions are "layered" on top of one another. Probabilistic methods are available for such evaluations, but were not employed in this stage of the risk assessment activities.

The assumptions and scenarios used in the BRA are inherently conservative and are not likely to underestimate any potential risk associated with this Site.

G.2 Ecological Risk Assessment Summary

The ecological risk assessment performed for the Site followed the process described in "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment," (USEPA, 1997). The guidance document describes an iterative screening and assessment process. The results of the third iterative stage or "Step 3-Problem Formulation" led to the following conclusions:

- available data are sufficient to conclude that Site-related compounds reported in soil, sediment and surface water do not pose significant ecological risk. A single compound, manganese, was detected in surface water at a maximum concentration (5,700 ug/L in 1998; 2,600 ug/L in 1999) and mean concentration (1,093 ug/L), both of which exceeded the benchmark of 120 ug/L for manganese. However, this risk is largely due to the application of total manganese concentrations to an extremely conservative benchmark, which is based on the dissolved metal concentrations. The limited potential for risk to aquatic life is supported by the sediment data. Although the maximum concentration of manganese exceeded the sediment benchmark of 819 mg/kg in 1998, the maximum concentration in 1999 (same location as the maximum in 1998) and overall mean concentration were below this benchmark.
- several naturally occurring metals were found in sediments. However, analyses performed provide strong evidence that the metal concentrations detected in sediments, as well as soils, reflect naturally-occurring concentrations. Accordingly, the potential for significant ecological risk due to Site-specific constituents is minimal.

The maximum concentrations of several metals in soils exceeded their conservative screening benchmarks, indicating the potential for unacceptable ecological risk. However, only copper and manganese slightly exceeded the threshold for unacceptable risk. To verify that metals in soils did not pose risk, an alternative statistical evaluation of metals was conducted. The evaluation, which was based on statistical correlation methods, demonstrated that the concentrations of metals in on-Site soils are indicative of naturally occurring concentrations and relationships among metals. Furthermore, the relationships are similar for both on-Site and background soils,

indicating that the apparent elevation of metals (i.e., exceedance of screening benchmarks) cannot be attributed to Site-related activities. Based on the weight-of-evidence from the two independent evaluations (traditional screening assessment and correlation analysis), it can be concluded that the concentrations of metals in on-Site soils do not pose unacceptable ecological risk.

G.3 Basis for Action

The response action selected in this Record of Decision is necessary to protect public health or welfare or the environment from actual or threaten releases of pollutants or contaminants from the Site which may present and imminent and substantial endangerment to public health or welfare.

H. REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) for the Aqua-Tech Site were developed from a review of the results of the site sampling data, site-specific risk and fate, transport evaluations, and review of ARARs. Operations conducted at the Site resulted in contamination of air, surface soils, subsurface soils and groundwater. The key COCs at the site include VOCs and metals. The clean-up levels were derived predominantly from the human health baseline risk assessment, with some coming from ARARs. At the Site, the potential cancer and non-cancer risks to potential future commercial, construction and irrigation workers and potential future residents exceeded the 1×10^{-6} and HQ=1 screening levels. The residential scenario was included for completeness of the BRA, although the future residential use of the Site and its environs is currently prohibited by a zoning ordinance related to the proximity of the Site to the Greenville-Spartanburg Airport. Therefore, clean-up levels for all media of concern at the Site, excluding groundwater are based on future commercial/industrial use. Clean-up levels for groundwater are based on future residential use since SCDHEC classifies the shallow groundwater beneath the Site as a potential source of drinking water. Under the NCP, EPA's goal is to reduce the excess cancer risk to the range of 1×10^{-4} to 1×10^{-6} . For this Site, EPA is choosing the clean-up levels of 1×10^{-6} for carcinogenic compounds and a HQ of 1 for most non-carcinogenic compounds based on the human health risk assessment and ARARs.

In summary, the RAOs for Site are to protect human health and the environment from exposure to contaminated air, soil, groundwater, and to restore the groundwater to a potential beneficial use as a drinking water source. The selected remedy meets these RAOs through treatment of soil and groundwater contaminated with VOCs. The RAOs also serve to facilitate the five-year review determination of protectiveness of human health and the environment. The RAOs for Site are listed below:

- i) to prevent or mitigate to the maximum extent practicable, direct human exposure to Site soils and/or the contents of the closed MSWL containing contaminants in excess of the potentially applicable ARARs (presented in Table 18) for the protection of human health;
- ii) to prevent exposure of human receptors to contaminated groundwater containing contaminant levels above State and Federal maximum contaminant levels (MCLs) established under the Safe Drinking Water Act;
- iii) to restore contaminated groundwater located outside the closed MSWL to the maximum extent practicable for future use consistent with the anticipated land use and potentially

- iv) applicable ARARs (presented in Table 18) within a reasonable time frame;
- iv) to control migration of contaminants from the Site to surface water by eliminating contact of stormwater runoff with landfill contents and contaminated surface soil; and
- v) to monitor the groundwater and soil in a manner to verify the effectiveness of the remedial actions.

I. DESCRIPTION OF ALTERNATIVES

The objective of this section is to provide a brief explanation of the remedial alternatives developed for the Site. A description of each alternative is presented below.

I.1 Description of Remedy Components

The following alternatives are grouped into three categories which include soil/groundwater alternatives, soil alternatives, and groundwater alternatives. Remedial alternatives for the Site are presented in the following summary table. Routine groundwater monitoring will be a component of any remedy selected with the exception of the "No Action" alternative. Costs for monitoring required over and above the routine monitoring (such as would be required for Monitored Natural Attenuation or Chemical Injection) are included in the appropriate alternative. Alternatives G3 and G4 for groundwater treatment, are evaluated as independent alternatives. However, it is anticipated that they would be combined with one of soil alternatives to address all impacted media at the Site.

Summary of Alternatives

Medium	FS Designation	Description	Cost
Soil/Groundwater	S1/G1	No Action	\$ 62,000
	S2/G2	Institutional Controls	\$ 810,000
Soil	S3	Site Capping	
	S3A	RCRA Subtitle D Cover	\$ 1,649,000
	S3B	RCRA Subtitle C Cover	\$ 5,202,000
	S3C	Mixed Cover/Cap	\$ 2,842,000
	S4	Site Capping and In-Situ Soil Treatment	\$ 3,355,000
Groundwater	G3	Chemical Injection	\$ 508,000
	G4	Monitored Natural Attenuation	\$ 340,000

I.1.1 Soil Alternatives and Groundwater Alternatives

Alternative S1/G1 - No Action

Estimated Capital Cost:\$0

Estimated Annual Operation and Maintenance (O&M) Cost: \$5,000

Estimated Present Worth Cost:\$62,000

Estimated Time To Completion: None

Satisfaction of Remedial Action Objectives: No

The No Action alternative is considered a baseline against which other alternatives are compared. With the No Action alternative, no remedial actions will be performed to actively reduce mobility, toxicity, or volume of the chemicals of concern found in the groundwater and associated soil. Under this alternative, no changes would be made to existing site conditions or exposure scenarios. This alternative relies on natural attenuation and degradation and leaching for the reduction of the chemicals of concern in the Site soils and groundwater.

Alternative S2/G2 - Institutional Controls and Monitoring

Estimated Capital Cost: \$100,000

Estimated Annual O&M Cost: \$57,000

Estimated Present Worth Cost:\$810,000

Estimated Time To Completion: \geq 2 years

Satisfaction of Remedial Action Objectives: Some

Institutional controls would limit the exposure pathways to soils and groundwater potentially containing contaminants of concern. Institutional controls may involve deed restrictions, well permitting requirements, zoning controls and access restrictions, and would mitigate the potential

risk to human health by restricting the potential exposure pathways. Use of the deed restriction involves placing a notation on the property deed which makes the current and any prospective property owner aware of the property's history and restricted land uses. The deed restriction may further place a limitation on future development and/or groundwater use. This would prevent or mitigate the potential of exposure to on-site contaminated soil or groundwater. Zoning controls could be used to restrict land development or groundwater withdrawals by potential groundwater users. Currently, the Site is zoned commercial/industrial. In addition, the Site is located within the "Airport Environs Area" as defined by the Greenville- Spartanburg Airport Environs Area zoning ordinance, dated March 29, 1996. This zoning ordinance precludes residential development and use of the Site. Access restrictions, such as the existing chain link fence surrounding the Site, can be used to limit human exposure to media at the Site which potentially contains contaminants of concern. However, it is anticipated that access restrictions may not be required following implementation of final remedial actions.

Groundwater monitoring would be performed using the existing well network supplemented by a minimum of two new wells. Results of the monitoring program will be used to evaluate the movement of Site related chemicals of concern in the groundwater. A monitoring plan would be developed to establish the procedures and protocols for groundwater sampling and analysis. The analytical data would be used to evaluate the migration of contaminants of concern from the Site and also to monitor background groundwater quality. Although groundwater monitoring would not reduce the present risk levels, it would provide the following:

- an early warning for the migration of contaminants from the Site; and,
- a better understanding and evaluation of the natural attenuation mechanisms in effect.

I.1.2 Soil Alternatives

Alternative - S3 - Site Capping

Under this remedial alternative, a cover designed in accordance with Subpart F- Closure and Post-Closure Care, (258.60: Closure Criteria) , Chapter 61 of the South Carolina Code (June 23, 1995), and 40 CFR 264, would be constructed over the MSWL to isolate the waste and to reduce infiltration and erosion. The Subpart F cover serves to prevent surface exposure to the environment, and to reduce or minimize infiltration. In developing these remedial alternatives for covering soil and municipal solid waste (MSW) at the Site, the locations of MSW and chlorinated compounds were considered. This Alternative S3 considers the implementation of a Subpart F, paragraph (a) RCRA soil cover and a multi-layer lined RCRA cover, and develops the option of combining lined and unlined cover systems. The alternatives for covering the waste are organized into three basic options: S3A RCRA Subtitle D Soil Cover; S3B-RCRA Subtitle C Cover, and; S3C Combination Cover.

Typical cross-sections for RCRA Subtitle C and D covers are illustrated on Figure 36.

Alternative - S3A - RCRA Subtitle D Cover

Estimated Capital Cost: \$1,319,000
Estimated Annual O&M Cost: \$22,000
Estimated Present Worth Cost: \$1,649,000
Estimated Time To Completion: 18 months
Satisfaction of Remedial Action Objectives: Moderate

Paragraph (a) of RCRA Subpart F defines Subtitle D cover requirements for closure of an inert pre-RCRA MSWL. The cover consists of an infiltration layer that reduces infiltration through the placement of a minimum 10^{-5} cm/second permeability layer of earthen fill material, and an erosion layer that supports vegetative cover and protects the infiltration layer. In general accordance with Subpart F, the infiltration layer is a minimum of 18 inches earthen material, and the erosion layer has a minimum thickness of one foot. There are no specific requirements for drainage slopes, although cover design must account for long-term erosion potential, and facilitate long-term maintenance.

Installation of a protective cover would consist of the following basic steps in sequence as identified in the Remedial Construction Plan:

- Establish entrance and egress points to maintain Site access control;
- Set up Site construction trailer(s), including power hookups and phone lines;
- Establish Site procedures in accordance with Site Health and Safety Plan;
- Import local sources of suitable infiltration layer material and vegetation layer materials; and,
- Conduct logical sequence of cover construction, consisting of clearing, grubbing, minor contouring, cover placement, compaction and testing, seeding and initial vegetation cover establishment.

It is anticipated that between 20,000 and 30,000 cubic yards of infiltration material will be required to cover the entire Site, and an additional 7,000 to 10,000 cubic yards of vegetative soil will be needed to protect the infiltration layer. These volumes assume existing cover material is unsuitable for the final cover. The depth and adequacy of the existing cover will be confirmed during the Remedial Design (RD) Stage. In areas of the cover where slopes are greater than approximately 1:4, a vegetation mat would be used to support initial vegetation cover.

Alternative - S3B - RCRA Subtitle C Cover

Estimated Capital Cost: \$4,448,000
Estimated Annual O&M Cost: \$57,500
Estimated Present Worth Cost: \$5,202,000
Estimated Time To Completion: 18 months
Satisfaction of Remedial Action Objectives: Moderate

Paragraph (k) of RCRA Subpart F defines closure cover requirements for "All facilities constructed with a liner system in accordance with this regulation", and recognizes post-RCRA MSWL construction with sub-liners and leachate collection systems. Paragraph (k) requires that the Subtitle C cover include a gas management layer, an infiltration layer, a flexible membrane liner and associated drainage layer, and a two foot erosion layer. Slope of the final cover must be between 2 percent and 33 percent. The RCRA Subtitle C cover considered in this alternative is consistent with Paragraph (k) but includes 24 inches of compacted clay with a permeability of 10^{-7} cm/second, and a 60 mil HDPE liner.

Alternative S3B RCRA Subtitle C Cover consists of installation of a multi-layer cover consistent with the requirements of Paragraph (k) and 40 CFR 264.228. After clearing and grubbing, common fill from local sources will be used to form a stable foundation for the subsequent cover components. The RCRA Subtitle C cover will consist of the following:

- A gas collection layer will be placed directly on the foundation layer. The gas collection layer will be composed of either coarse granular material, or a geocomposite material specifically designed to facilitate planer flow. The geocomposite may also incorporate an additional impermeable liner that provides a percolation flow barrier layer to prevent vertical water flow.
- A compacted clay layer 24 inches thick, compacted to a maximum permeability of 10^{-7} cm/second, will be placed above the gas conduction layer. A 60 mil HDPE flexible membrane liner (FML) will be placed directly on the compacted clay, forming an impervious percolation barrier.

To provide for adequate percolated water removal rates above the impervious barrier, a conduction layer of either granular material or geocomposite will be engineered to conduct percolated water to collection laterals. This conduction layer will be covered with a 24 inch earthen material to form an infiltration layer of suitable thickness, and to serve as a foundation for the topsoil vegetation layer. During the RD phase, the engineering and cost trade-off between geocomposites versus local availability of suitable cover construction materials will be analyzed.

Implementation of a barrier cover would proceed in approximately the same sequence as a RCRA Subtitle D cover, including:

- Establish entrance and egress points to maintain site access control;
- Set up Site construction trailer(s), including power hookups and phone lines;
- Establish Site procedures in accordance with Site Health and Safety Plan;
- Import local sources of suitable foundation fill, infiltration layer material and vegetation layer materials; and,
- Conduct logical sequence of cover construction, consisting of clearing, grubbing, minor contouring, cover placement (including gas collection, impervious layers, drainage layer,

and toe drain collection system), compaction and testing, seeding and initial vegetation cover establishment.

The integrity of the impermeable layers in the barrier cover will be monitored and controlled during construction through implementation of a Construction Quality Assurance Plan, and proper technical documentation in accordance with specifications in the RD.

Alternative - S3C - Combination Cover

Estimated Capital Cost: \$2,346,000
Estimated Annual O&M Cost: \$40,000
Estimated Present Worth Cost: \$2,842,000
Estimated Time To Completion: 18 months
Satisfaction of Remedial Action Objectives: Moderate

This alternative consists of utilizing an impermeable liner with associated gas and drainage layers in areas of the Site where halting all infiltration is desirable regardless of the impact on current active reductive dechlorination processes consistent with the approach described in Alternative S3B. Other areas of the Site would be covered in accordance with Paragraph (a) of Subpart F, consistent with the approach described in Alternative S3A. Alternative S3C is designed to allow impermeable capping of areas of the Site that have been shown to have elevated chlorinated ethenes in soil, MSW, or groundwater, while using soil cover for areas of the Site that present little or no potential groundwater impact threat.

Alternative - S4 - Site Cover with In Situ Soil Treatment

Estimated Capital Cost: \$2,736,000
Estimated Annual O&M Cost: \$40,000 (landfill cap) + \$30,000 (In Situ Soil Treatment System)
Estimated Present Worth Cost: \$3,355,000
Estimated Time To Completion: 18 months for cover, 5 years for Soil Vapor Extraction (SVE)
Satisfaction of Remedial Action Objectives: High (Primarily soil)

This alternative combines isolation of soil and MSW through construction of a soil or RCRA Subtitle C cover, with a mechanical Soil Vapor Extraction (SVE) system to aggressively pursue the removal of chlorinated compounds in soils above the MSW in the former Process Distillation Area at the Site. It is anticipated that the SVE collection network would replace the layer for passive gas collection. This alternative offers the advantage of physical removal of the chlorinated compounds and therefore is preferred over remedies that only isolate or cover volatile contaminants in the soil. In areas of the Site where it is unlikely that short-circuiting of airflow will occur, horizontal soil vapor collection lines would be trenched into the soil above the MSW deposits using a vibratory trencher. No excavation or soil removal would be used in the installation of these laterals.

If SVE is combined with Alternative S3A - RCRA Subtitle D Soil Cover, then it may be desirable to install a lower permeability clay layer (i.e.: 10^{-6} or 10^{-7} cm/second) and also to install a drainage layer above the clay to prevent excess water accumulation in the treatment system. If a geocomposite drainage layer is used in the final RD, then a FML can be incorporated into the geocomposite and ensure optimum SVE conditions.

Potential subsidence of waste as a result of composting of wood debris in the MSW could cause problems in cover integrity, particularly in the geosynthetics and flexible membrane liner. Two solutions are 1) to measure small temperature increases resulting from the in situ oxidation process; and 2) to periodically survey inert points on the barrier cover placed throughout the waste cover that penetrate to the surface providing surface detection of interior layer movement.

I.1.3 Groundwater Alternatives

Alternative - G3 - Chemical Injection

Estimated Capital Cost: \$508,000

Estimated Annual O&M Cost: \$0

Estimated Present Worth Cost: \$508,000

Estimated Time to Completion: 3 - 5 years

Satisfaction of Remedial Action Objectives: High (Primarily Groundwater)

Chemical injection involves thoroughly permeating contaminated zones with a chemical oxidant or reductant (potassium permanganate, sodium lactate, hydrogen peroxide, ozone, etc.) to induce oxidation-reduction (redox) reactions resulting in the complete destruction of COCs. The injectant can be placed as a slurry or as a reactive barrier wall.

Chemical oxidants such as potassium permanganate and sodium persulfate are rapid and aggressive, and insensitive to chemical contaminant characteristics and concentrations. They directly oxidize petroleum products or chlorinated solvents, producing carbon dioxide as a byproduct. Many groundwater contaminants can also be treated through enhancement of anaerobic biological reductive degradation (biodegradation). When natural degradation of these compounds is limited by an inadequate source of food (electron donors), introducing a food source into the subsurface can enhance the natural processes and keep the plume from starving. One of the most effective and environmentally benign food sources are volatile fatty acids. Of these, lactic acid or inorganic lactate salts are prevalent in the food and cosmetic industry and are, therefore, readily available and fairly inexpensive.

For effective treatment to take place, a sufficient mass of chemical must be injected to react with both the contaminants and background sinks or interferences, and the injectant must reach the majority of the contaminant mass. The main limitation on treatment effectiveness at the Site will be the low permeability of the soils. The chemical application method can be modified as needed to utilize hydraulic fracturing and liquid atomized injection to improve delivery to the subsurface. Hydraulic fracturing improves the rate of delivery, and liquid atomized injection improves the

uniformity of the injection. Hydraulic fracturing involves the injection of fluids at pressures that exceed the combined lithostatic pressure (weight of soil column) and cohesive strength of the soil. With hydraulic fracturing, the formation is temporarily "lifted." This increases the permeability substantially and allows solids, liquids or gases to be injected at a higher rate than without fracturing. If long term permeability enhancement is desired, coarse sand can also be co-injected to leave the pore spaces open after the fracturing is completed. Liquid atomized injection involves the injection of significant quantities of air along with a solid or liquid. The injected air atomizes the liquid to create a mist, or with solids increases the velocity. Liquid atomized injection promotes uniform distribution of the injected materials, and is often used in combination with hydraulic fracturing so that the materials will be dispersed away from the hydraulic fractures. The use of hydraulic (or pneumatic) fracturing can be used for injection within the unsaturated zone.

Alternative - G4 - Monitored Natural Attenuation

Estimated Capital Cost: \$40,000
Estimated Annual O&M Cost: \$60,000 (for 5 years)
Estimated Present Worth Cost: \$340,000
Estimated Time to Completion: 15 - 30 years
Satisfaction of Remedial Action Objectives: Long-Term

Monitored Natural Attenuation is the monitored use of the natural processes of intrinsic bioremediation, advection, dispersion, and sorption to remove contaminants from groundwater. It requires a structured program of groundwater monitoring of biological and chemical parameters to determine that the transformation processes are taking place at a rate that is protective of human health and the environment, and that the processes will continue at an acceptable rate for an extended period of time. Because engineering controls are not used to control plume migration, it is necessary to ensure that natural attenuation is appropriate to address all contaminants of concern in the groundwater.

The majority of source material for the detected VOCs was removed during the removal activities performed in 1992, as evidenced by the Site-wide drop in total VOC concentrations in groundwater. The landfill area does not appear to be a significant source of VOCs, and free product does not appear to be present at the Site. The extent of the contaminant plume appears to be stable and is not migrating. The use of natural attenuation does not rely upon cross-media transfer of contaminants (i.e., sorption), and would be protective of human health and the environment.

The rate of attenuation at each monitoring well location varies suggesting that bioattenuation rates are not sufficient to utilize natural attenuation as the sole remedial action Site-wide. Historical groundwater sampling data suggests that the landfill serves as a significant carbon source for natural attenuation. As a result, placement of a low-permeability cap over the old municipal landfill, effecting a reduction in leachate production, could potentially initiate renewed migration of the contaminant plume after the rate of bioattenuation decreases due to reduction of the carbon source. Use of natural attenuation will be a long-term application, because of the present inability

to reduce concentrations (reduction rate lower than source contribution) of all contaminants in all areas.

I.2 Common Elements and Distinguishing Features of Each Alternative

Alternative 1 for each of the media (soil and groundwater) is the No Action alternative. This alternative includes the 5-year review which would be required if this alternative is chosen.

Alternative 2 for each of the media is Institutional Controls with monitoring for groundwater. The monitoring would be conducted annually, in addition to a 5-Year Review.

Alternatives 3A, 3B, 3C and 4 for soil include the common element of capping. The type of cap varies between the alternatives, but the clean-up levels are the same. All of the alternatives would require selecting the groundwater alternative G3 (Chemical Injection) in order to fully comply with ARARs.

J. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, each alternative is evaluated using the nine evaluation criteria required in Section 300.430(f)(5)(i) of the NCP. Table 14 located at the end of section J.3.2, provides a summary of the information that follows.

J.1 Threshold Criteria

J.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Alternative S1/G1 - No Action does not change the current or potential future risks to human health or the environment identified in the RI, BRA or ERA. All 4 remaining Alternatives provide varying degrees of protection.

Alternative S2/G2 - Institutional Controls will provide protection for specific future human exposure scenarios identified at the Site.

Alternative S3 - Site capping will address various direct exposure risks identified in the RI, BRA and ERA. No individual Alternative is completely protective of human health and the environment relative to all media. Alternatives S2 and S4 collectively address risks represented by contaminated soil at the Site. Alternatives G2 and G3 address current and potential future risks associated with groundwater.

J.1.2 Compliance with ARARs

Section 121 (d) of CERCLA and NCP § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable Federal and State requirements, standards, criteria, and limitations which are collectively referred to as “ARARs”, unless such ARARs are waived under CERCLA section 121(d)(4). Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate. Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for an invoking waiver.

Alternatives S1/G1 and S2/G2 do not comply with various ARARs identified for the Site. Alternative S3 must be incorporated into the final remedy to comply with current South Carolina municipal landfill closure requirements. The natural attenuation processes at the Site are quite variable from location to location. Therefore, there is no assurance that Alternative G4 would universally comply with ARARs or remedial goal objectives within a reasonable time period. Alternatives S4 and G3 reduce the time required for the Site to comply with media specific ARARs. However, media related ARARs do not specifically apply to contaminant concentrations within media situated beneath the limits of the landfill cover.

J.2 Primary Balancing Criteria

J.2.1 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain on-site following remediation and the adequacy and reliability of controls. Each alternative, except the No-Action alternative, provides some degree of long-term protectiveness. The alternatives increase in effectiveness of reducing potential exposure through increasing containment or treatment as additional or enhanced options are added. Reviews at least every five (5) years, as required, would be necessary to evaluate the effectiveness of any of these

alternatives because hazardous substances would remain on-site in concentrations above health-based levels.

Alternative S1/G1 does not provide a permanent remedy or actively reduce long-term risks. Institutional Controls provided in Alternative S2/G2 will be effective in mitigating specific long-term exposure risks provided they are enforced. Failure to enforce Institutional Controls may impact the long-term effectiveness and permanence of any Alternative that is chosen. Long-term groundwater monitoring included in Alternative S2 will evaluate the effectiveness of natural attenuation mechanisms at the Site if implemented with no other action or will serve to monitor the long-term effectiveness of any other remedy selected for implementation.

The various Site caps offered under Alternative S3 are equally effective for their intended purpose. Alternative S3B is considered the most permanent Alternative due to the thickness of the layers and redundancy inherent in the design (i.e. if the synthetic liner fails the clay barrier still restricts infiltration). The effectiveness and permanence of each Alternative is dependent on long-term maintenance of the surface.

Combined Alternatives S4 and G3 provide the greatest level of permanence and long-term effectiveness through the permanent reduction in contaminant mass in soil (Alternative S4) and groundwater (Alternative G3). It is anticipated the implementation of both Alternatives will be complete within 5 years. However, the short duration of the implementation results in a permanent and long-term reduction of risk at the Site.

J.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternatives S1/G1, S2/G2 and G4 provide no reduction in toxicity, mobility or volume other than what will be reduced by natural attenuation and degradation processes. Although natural attenuation processes may be effective in reducing some contaminant concentrations, they are unlikely to achieve all chemical specific ARARs in a reasonable time frame.

Alternative S3 will reduce the mobility of certain contaminants by reducing or eliminating infiltration of precipitation and thereby reduce the leaching potential of leachable constituents. Alternative S3B provides the greatest level of protection from leaching and would therefore be appropriate for areas where residual contaminant sources remain a direct threat to groundwater. This alternative will not reduce the toxicity or volume of contaminants at the Site. Alternatives S4 and G3 will both reduce contaminant volumes and toxicity. Alternative S4 includes an SVE component that will reduce the concentrations of VOCs in the soil. Alternative G3, Chemical Injection will treat contaminants in soil and groundwater through chemical degradation and/or by enhancing natural biodegradation mechanisms.

J.2.3 Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup goals are achieved.

None of the Alternatives considered pose any substantive incremental increased risks to the community, the workers or the environment in the short-term during implementation.

Alternative S3 involves the risks inherent in moving substantial volumes of clean soil through portions of the community. However, potential exposure to contaminated media will be limited and can be controlled through proper design. Alternative S4 retains the risks of Alternative S3 plus added potential exposure to VOCs during installation of the SVE system. The exposure to VOCs or potential releases of VOCs during system installation is readily managed through monitoring and engineering controls.

Alternative G3, Chemical Injection, has some inherent incremental risks due to the need to handle and inject chemicals into the subsurface. Potential exposure risks are limited and would be further mitigated through proper handling of the chemicals and monitoring during injection.

J.2.4 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

All 5 Alternatives can be readily implemented and are based on demonstrated technologies. Alternative S3 provides various implementation challenges due to the volumes of materials to be imported to the Site and the presence of steep side slopes around the southeastern and southern limits of the MSWL. The construction challenges will be addressed during the RD stage.

J.2.5 Cost

Includes estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

The estimated costs for the remedial alternatives range from \$62,000 (No Action) to \$5,202,000 (RCRA Subtitle C Cap).

Each Alternative is focused on a different target or media and therefore a direct comparison of costs between major Alternative groups is not appropriate.

Cost comparisons between capping options under Alternative S3 are appropriate with the capping estimates ranging from \$1,592,000 for a RCRA Subtitle D soil cover to \$5,202,000 for a RCRA Subtitle C cover. As noted, the RCRA Subtitle C cap costs over 3 times more than the standard soil cover and therefore should only be considered in areas that warrant the additional level of protection provided by the RCRA cap.

J.3 Modifying Criteria

J.3.1 State/Support Agency Acceptance

Considers whether the State agrees with EPA's analyses and recommendations, as described in the RI/FS and Proposed Plan.

SCDHEC has reviewed this ROD and concurs with the selected remedy.

J.3.2 Community Acceptance

Considers whether the local community agrees with EPA's analyses and preferred alternative.

Only one written comment was received on the Proposed Plan, and only a few comments were provided in the public meeting. Therefore, it is difficult to determine community acceptance of the alternatives. One person recommended in writing to select Alternative G4 - Natural Attenuation for the entire Site. There were no vocalized objections to any of the alternatives. Of those comments expressed, most were related to costs and source of funding for the cleanup.

Table 14 - Summary of Comparative Analysis of Alternatives

<i>Evaluation Criteria</i>	<i>Alternative S1/G1 No Action</i>	<i>Alternative S2/G2 Institutional Controls</i>	<i>Alternative S3A RCRA Subtitle D</i>	<i>Alternative S3B RCRA Subtitle C</i>
Overall Protection of Human Health and Environment				
Reduction of Risks to Chemicals in				
Groundwater	No Risk Reduction	Risk Reduction through controlled use	Reduces Potential Future Contamination	Reduces Potential Future Contamination
Soil	No Risk Reduction	Limited Risk Reduction	Risk Reduced	Risk Reduced
Use of Site After Remediation	Restricted Use	Restricted Use	Restricted Use	Restricted Use
Compliance with ARARs				
Chemical-Specific ARARs				
Groundwater	NO	LONG-TERM	LONG-TERM	LONG-TERM
Soil	NO	NO	NO	NO
Action-Specific ARARs	YES	YES	YES	YES
Location-Specific ARARs	YES	YES	YES	YES
Long-Term Effectiveness and Permanence				
Magnitude of Residual Risk				
Chemicals in Soil	No Risk Reduction	Reduces risk if Site use Restricted	Eliminates exposure to Soil Contaminants	Eliminates exposure to Soil Contaminants
Chemicals in Groundwater	No Risk Reduction	Reduces risk if Site use Restricted	No Change	No Change
Adequacy and Reliability of Controls	Contaminants Remain on Site	Contaminants Remain on Site and exposure potential reduced if ICs enforced	Soils and Wastes in Landfill permanently isolated under CAP	Soils and Wastes in Landfill permanently isolated under CAP
Satisfaction of Remedial Action Objectives	NO	NO	MODERATE	MODERATE

Table 14 (con't) - Summary of Comparative Analysis of Alternatives

<i>Evaluation Criteria</i>	<i>Alternative S3C Combined</i>	<i>Alternative G3 Chemical Injection</i>	<i>Alternative S4 Site Capping and In Situ Soil Treatment</i>
Overall Protection of Human Health and Environment			
Reduction of Risks to Chemicals in			
Groundwater	Reduces Potential Future Contamination	Risk Reduced	Reduces Potential Future Contamination
Soil	Risk Reduced	N/A	Risk Reduced
Use of Site After Remediation	Restricted Use	Restricted Use	Restricted Use
Compliance with ARARs			
Chemical-Specific ARARs			
Groundwater	LONG-TERM	YES	LONG-TERM
Soil	NO	NO	NO
Action-Specific ARARs	YES	YES	YES
Location-Specific ARARs	YES	YES	YES
Long-Term Effectiveness and Permanence			
Magnitude of Residual Risk			
Chemicals in Soil	Eliminates exposure to Soil Contaminants	No Risk Reduction	Reduces Soil Risk through destruction of contaminants
Chemicals in Groundwater	No Change	Permanently eliminates Risk	Reduces Risk
Adequacy and Reliability of Controls	Soils and Wastes in Landfill permanently isolated under CAP	Contaminants in Groundwater Destroyed	Soils and Waste isolated, VOCs in Process Distillation Area destroyed
Satisfaction of Remedial Action Objectives	MODERATE	HIGH (PRIMARILY GROUNDWATER)	HIGH (PRIMARILY SOIL)

Table 14 (con't) - Summary of Comparative Analysis of Alternatives

<i>Evaluation Criteria</i>	<i>Alternative S1/G1 No Action</i>	<i>Alternative S2/G2 Institutional Controls</i>	<i>Alternative S3A RCRA Subtitle D</i>	<i>Alternative S3B RCRA Subtitle C</i>
<u>Reduction of Toxicity, Mobility and Volume</u>				
Quantity of Chemicals Treated or Destroyed in:				
Soils	NONE	NONE	NONE	NONE
Groundwater	NONE	NONE	NONE	NONE
Disposition of Treatment Residuals	N/A	N/A	N/A	N/A
<u>Short-Term Effectiveness</u>				
Community Protection	No Change	Limited Based on Controlled Land Use	No risk to Community	No risk to Community
Worker Protection	N/A	N/A	Protection/Controls required during construction	Protection/Controls required during construction
Environmental Impacts	No Change	No Change	Impacts Reduced	Impacts Reduced
Time To Completion	N/A	Less than 2 years	18 Months	18 Months
<u>Implementability</u>				
Technical Feasibility				
Difficulty in Construction	N/A	LOW	LOW	HIGH
Potential for Delays Due to Technical Problems	N/A	LOW	LOW	MODERATE
Availability of Services and Materials	N/A	HIGH	MODERATE	MODERATE
<u>Costs</u>				
Capital Costs	\$ -	\$ 100,000	\$ 1,319,000	\$ 4,488,000
Operation and Maintenance Present Worth	\$ 5,000	\$ 710,000	\$ 273,000	\$ 714,000
Total Cost	\$ 62,000	\$ 810,000	\$ 1,592,000	\$ 5,202,000
<u>Recommended</u>				
	NO	INCLUDE IN FINAL REMEDY	NO	NO

Table 14 (con't) - Summary of Comparative Analysis of Alternatives

Evaluation Criteria	Alternative S3C Combined	Alternative G3 Chemical Injection	Alternative S4 Site Capping and In Situ Soil Treatment	Alternative G4 Monitored Natural Attenuation
Reduction of Toxicity, Liability and Volume				
Quantity of Chemicals Treated or Destroyed in				
Soils	NONE	NONE	HIGH	NONE
Groundwater	NONE	HIGH	LOW	NONE
Disposition of Treatment Residuals	N/A	NONE	SVE Discharge to atmosphere	N/A
Short-Term Effectiveness				
Community Protection	No risk to Community	No risk to Community	No risk to Community	No Short-Term Change
Worker Protection	Protection/Controls required during construction	Protection/Controls required during injection	Protection/Controls required during construction	N/A
Environmental Impacts	Impacts Reduced	Mitigates prior GW impacts	Reduced Impacts	No Short-Term Change; Impacts Monitored
Time To Completion	18 Months	3 to 5 years	18 Months for cover, 5 years for SVE	15 to 30 years
Implementability				
Technical Feasibility				
Difficulty in Construction	LOW	LOW	MODERATE	N/A
Potential for Delays Due to Technical Problems	LOW	LOW	MODERATE	N/A
Availability of Services and Materials	MODERATE	HIGH	MODERATE	N/A
Costs				
Capital Costs	\$ 2,346,000	\$ 508,000	\$ 2,736,000	\$ 40,000
Operation and Maintenance Present Worth	\$ 496,000	\$ -	\$ 619,000	\$ 300,000
Total Cost	\$ 2,842,000	\$ 508,000	\$ 3,355,000	\$ 340,000
Recommended				
	NO	INCLUDE IN FINAL REMEDY	INCLUDE IN FINAL REMEDY	Maybe included in later stages with reduced monitoring frequency once active treatment is complete

K. PRINCIPAL THREAT WASTE

The NCP establishes an expectation that the USEPA will use treatment to address principal threats posed by a site wherever practicable (NCP §300.430(a)(1)(iii)(A)). The ‘principal threat’ concept is applied to the characterization of ‘source materials’ at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, surface water or air, or acts as a source for direct exposure. Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only low risk in the event of exposure. According to *A Guide to Principal Threat and Low Level Threat Wastes (OSWER 380.3-06FS, November 1991)*, wastes that generally do not constitute principal threats include, but are not limited to the following: (1) non-mobile contaminated source material of low to moderate toxicity (surface soil containing COCs that generally are relatively immobile in air or ground water, i.e., non-liquid, low volatility, low leachability contaminants such as high molecular weight compounds) and (2) low toxicity source material (soil and subsurface soil concentrations not greatly above reference dose levels or that present an excess cancer risk near the acceptable risk range were exposure to occur).

Although treatment will be applied to the VOC contaminated soil and groundwater, there are no principal threats at the Aqua-Tech Site. The VOC soil contaminants are mobile and may act as a potential threat to groundwater but are low in concentration. The non-VOC soil contaminants pose a risk to human health but are not mobile and are characterized by relatively low concentrations within a confined area. Groundwater contamination at Site is at low concentrations and not considered to be a source material. Furthermore, DNAPLs have not been detected in the groundwater. Therefore, EPA does not consider any of the wastes at the Aqua-Tech Site to be "principal threat" wastes.

L. SUMMARY OF THE SELECTED REMEDY

L.1 Description of the Remedy

The preferred remedial alternative will combine elements of Remedial Alternatives S2/G2, S4 and G3. The primary remedial activities will consist of the following:

- 1) Site Capping using a combination of a RCRA Subtitle C Cover and RCRA Subtitle D soil cover for different portions of the municipal landfill to ensure all municipal waste is isolated from exposure and provide an extra level of protection in areas where the greatest concentrations of VOCs were reported;

- 2) In Situ Soil Treatment in the former Process Distillation Area to reduce the mass of VOCs in shallow soils throughout this area;
- 3) In Situ Groundwater Treatment by chemical injection to immediately reduce the contaminant mass and enhance the long term biodegradation of residual VOCs in groundwater. Once in situ treatment is complete, final remediation of groundwater will be achieved through natural attenuation;
- 4) Routine groundwater monitoring and Site inspections to assess the effectiveness and integrity of the selected remedial alternative; and,
- 5) Institutional Controls to restrict use and development of the Site to minimize public exposure to residual contaminants, and to ensure the long-term integrity of the remedy.

The primary elements of the selected remedy are illustrated on Figure 37. A detailed summary of the components of the selected remedy provided below.

Site Capping

Construction of the RCRA Subtitle C cap and RCRA Subtitle D soil cover will involve the handling of in excess of 66,000 cubic yards of soil and granular material. The approximate limits of the RCRA cap and soil cover are illustrated on Figure 36. The limits will be confirmed during the RD phase.

During performance of the ERA, it was anticipated that certain historic sample locations situated outside the actual limits of the landfill would be incorporated beneath the presumptive remedy cover. The specific sample location designations include: SB-08, 509-07, 510-01, 510-03, 601-01, 601-02, and 601-03. Of these locations:

SB-08, only manganese exceeded its screening value but the reported concentration was consistent with background levels; and,

509-07, 510-01 and 510-03 had concentrations of COCs that were well within the range of other samples well outside the limits of the presumptive remedy that did not trigger a concern.

The remaining locations were identified due to elevated concentrations of metals that represented a potential ecological risk but no other concern. Consequently, soils in these areas are suitable for common fill for rough grading beneath the landfill cover or may simply be covered (to be assessed during RD stage). In addition, soil in the PCL₃ Area (specifically sample location PCL-SA) was identified as a potential hot spot in the BRA. The soil contained slightly elevated concentrations of arsenic (65.6ppm) and Iron (24,800ppm) and does not represent a threat if used as common fill beneath the proposed MSWL cover. All other potential soil hot spots identified

in the BRA were within the limits of the landfill and will be isolated beneath the soil cover.

Pre-construction activities will include procurement of nearby sources of earthen material, permitting, etc.

The RCRA Subtitle D soil cover to be placed over the MSWL will meet the closure cover requirements of Chapter 61 of the South Carolina Code (June 23, 1995) and consist of:

- a minimum of 18 inches of earthen fill with a maximum in-place permeability of 1×10^{-5} cm/sec; and
- a minimum of 12 inches of soil suitable to support vegetation.

This cross section may be modified during the RD for portions of the Site with existing slopes that exceed 1:4. In these areas, the slope of the land is sufficient to shed precipitation and the primary objective will be to secure the slopes against erosion and protect adjacent streams, creeks and ravines. In these areas, a vegetation mat is proposed to support rapid development of a secure vegetation cover. Existing Site soils and cover material may be incorporated into the design where such soils meet the desired physical characteristics and their use is not precluded due to the presence of chemicals of concern.

The RCRA Subtitle C cover to be placed over the process distillation area will consist of:

- common fill for rough-grading;
- a minimum of 24 inches of compacted clay with a maximum permeability of 1×10^{-7} cm/sec;
- a 60 mil HDP FML placed on top of the clay;
- a drainage layer placed on top of the FML to convey precipitation that infiltrates to the FML; the drainage layer may be a synthetic Geocomposite or granular layer with lateral drainage; and,
- a 24 inch thick earthen infiltration layer to protect the infiltration barriers and support a cover of vegetation.

A RCRA Subtitle C cover typically incorporates a gas venting system. The SVE system will replace the gas venting system in the preferred remedy. The placement of the SVE system will generally coincide with the RCRA cover and will serve as an active venting system while in operation and can remain in place to function as a passive venting system once the SVE is no longer beneficial for soil treatment.

In Situ Soil Treatment

Implementation of SVE in combination with the RCRA Subtitle C cover in the Process Distillation Area will entail careful planning and design of the placement, size and configuration of collection laterals. Areas will be avoided where there is only a thin soil cover over MSWL,

or where there is no evidence of removable volatile constituents. Where there are surface obstructions such as concrete foundations, the surface obstruction will be either broken or penetrated to allow proper and complete distribution of the SVE collection network or the pipe may be relocated to a more suitable location. Final layout for SVE equipment sizing, instrumentation and controls, and operation with maintenance will be defined during the RD stage.

In Situ Groundwater Treatment

Based on the detailed evaluation of remedial alternatives, the single remedy that appears to have the greatest potential to treat residual contamination in groundwater in a reasonable period of time is chemical injection. Therefore, in situ chemical injection into affected areas to stimulate degradation of chlorinated solvent contaminants in groundwater is proposed as the most efficient and cost-effective short-term remedial approach for groundwater treatment at the Aqua-Tech Site.

The immediate impacts from chemical injection will vary. To ensure the treatment is effective, it will be performed in an iterative manner, with interim monitoring performed between injection events, and the scope of subsequent injection events developed based on the results of prior events.

Treatability Testing

Samples will be collected during the remedial design phase for treatability testing. Saturated soil and groundwater samples will be tested for the following:

- total oxidant demand;
- reactivity to oxidants (e.g., potassium permanganate and sodium persulfate);
- reactivity to reductants (e.g., sodium lactate and HRC);
- background metals; and,
- physical and geochemical properties.

Injection Program

The chemical injection program for impacted groundwater will be conducted as an iterative process, where results of injection in a particular area or groundwater zone will determine the direction and focus of subsequent injections. Specifically, the type of injectant used for a particular location, oxidant or reductant, will be determined based on the results of the treatability study, contaminant concentrations, and level of natural attenuation taking place. Also, results from a particular round of injection will determine the necessity and degree of subsequent injection to achieve preliminary remediation goals. Injection will be initiated first in upgradient areas, with downgradient areas monitored for possible contaminant reduction due to upgradient source reduction. Finally, injection will first take place within the saprolite zone, with the

shallow bedrock zone concurrently monitored for potential attenuation effects, in order to determine whether subsequent injection into the shallow bedrock will be necessary.

Oxidants will be used for injection in the vicinity of the highest observed groundwater concentrations of tetrachloroethene and trichloroethene, where the ratio of PCE/TCE to daughter products is high. Based on existing data, it is expected, but not limited to, that this would be predominantly in the vicinity of MW-1 (Administration Area).

Reductants will be injected downgradient, in the vicinity of the 601/602 Area, where there is significant production of daughter products, indicating anaerobic biodegradation is ongoing. Injection of oxidants in these areas would disrupt the anaerobic bioactivity. Specifically, reductants would be introduced in the vicinity of wells MW-3, MW-11, and MW-20.

Application of chemical injection will be conducted in phases. The chemicals will be injected at a sufficient number of points such that there is an adequate overlap of effective injection "cones". It is anticipated that each injection point will have an effective treatment radius of 20 feet. Uncertainty in complete coverage is due to the effect of soil texture heterogeneities on transport of the injected material. This leads to using a phased injection approach, where results can be used to guide future adjustments in the application grid.

During the initial injection in the saprolite in each treatment area, soils above the water table will be screened to ensure no residual source of VOCs remains in the overlying soils in the areas to be treated. If pockets of significant VOC contamination are observed in the vadose zone soils, such soils will also be treated by chemical injection.

The downgradient monitoring wells TW-1, MW-4, MW-6, MW-10, and MW-19 will be monitored following injection at the upgradient points.

Concentration levels in downgradient wells will be monitored for response to the upgradient injections to determine whether injection should be performed at downgradient points.

Performance Monitoring

Performance monitoring will be conducted after full-scale injection has taken place as a measure of the effectiveness of the technology. Approximately three months after injection, groundwater analytical data will be collected from selected monitoring wells for confirmation of application effectiveness. The performance monitoring results will be used to guide adjustments in the application grid and determine the need for reapplications. It is anticipated that several additional monitoring wells will be added for baseline assessment and performance monitoring in the 505 and 510 Areas. Once the primary aqueous contaminant plumes are addressed, if Preliminary Remediation Objectives have still not been met, it may be possible to rely on natural attenuation, allowing the natural bio-activity to address remaining low concentrations of COCs in a cost-effective manner. However, EPA believes that substantial compliance can be met with this

focused, iterative injection approach.

Injection

The State of South Carolina requirements for a Class 5 Injection Well Permit Underground Injection Control (UIC) Program will be complied with.

Site Monitoring

The Site monitoring program will include inspection/monitoring activities for specific components of the remedy (i.e. cap inspections) and routine groundwater monitoring to assess the overall effectiveness of the combined remedy.

Two additional monitoring wells will be installed to supplement the existing monitoring well network. Routine monitoring will consist of annual sampling of the entire monitoring well network for a period of at least 5 years. It is anticipated that the monitoring well network and analyte list will be compressed after 5 years based on the annual sampling results.

Samples collected for annual monitoring in years 1 through 5 will be analyzed for:

TCL VOCs
TCL SVOCs
TAL Metals

The analyte list for the subsequent events will be developed based on the results of the first 5 years of the annual monitoring program and interim events performed to support the in situ groundwater treatment program.

Where possible, the annual sampling event will be scheduled to coincide with any focused monitoring to be performed relative to the chemical injection program (or vice-versa).

Institutional Controls

Institutional Controls proposed and currently in place at the Site include:

- i) zoning ordinance to preclude residential development consistent with the Airport environs zoning restrictions; and,
- ii) deed restrictions to protect the integrity of implemented remedies and ensure MSW left in place is not disturbed.

The current Airport Environs zoning ordinance precludes residential development of the Site but permits commercial/industrial development. Potential future industrial development may be accommodated on portions of the Site outside the limits of the MSWL and cap/cover.

Deed restrictions will, as a minimum, be required to ensure covers, caps, and other remedial components are protected and municipal waste left in place is not disturbed in the future.

Access Restrictions

Access Restrictions proposed and currently in place at the Site include:

- i) Site fencing to restrict access during implementation of remedial measures;

Fencing will be required as an interim measure pending completion of the selected remedy. The design of the final remedy for the Site should therefore not rely on fencing to ensure the integrity of the final remedy and mitigate potential exposure scenarios.

L.2 Summary of the Rationale for the Selected Remedy

Remedial Alternative S1/G1 was omitted from consideration due to its inability to reduce the toxicity, volume or mobility of Site contaminants in a reasonable time.

Remedial Alternative S2/G2 - Institutional Controls, will be incorporated into the preferred remedy to restrict access to the Site during implementation of remedial action, restrict long-term use of the Site to protect remedial measures and provide long-term inspections and monitoring. Once implemented, the preferred remedy will not rely on access restrictions (fencing) to maintain protection of public health.

Remedial Alternative S3 effectively isolates residual soil contamination but does not reduce the toxicity or mass of contaminants and does not fully address groundwater impacts from historic Aqua-Tech operations if implemented on its own.

Remedial Alternative S4 incorporates the capping benefits of Alternative S3 and provides for further reduction of contaminant toxicity and mobility through focused soil treatment but does not specifically impact groundwater quality in the short term. Alternative G3 provides accelerated treatment of groundwater through chemical oxidation. Alternative G4 will not provide accelerated treatment of groundwater. However, Alternative G4, Monitored Natural Attenuation, may provide long-term remediation of residual groundwater contamination remaining after accelerated treatment (i.e. Alternative G3). A combination of focused soil and groundwater treatment actions provides the greatest level of protection without redundancy.

L.3 Summary of Estimated Remedy Costs

The estimated capital costs of the selected remedy is \$3,344,000. The estimated net present worth cost of the selected remedy is \$4,673,000. The information in this cost estimate summary is based on the best available information regarding the scope of the selected remedy. Cost variations are likely to occur as new information and data are collected during the design phase. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the

actual project cost. Table 15 contains a detailed breakdown of estimated costs.

Table 15 - Estimated Cost of the Remedy

Remedy Costing Component	Capital Cost (Years 1-3)	O&M Costs (7% Discount)
Alternative S2/G2: Institutional Controls	\$100,000	\$710,000
Alternative S4: SVE with Combined Cover	\$2,736,000	\$619,000
Alternative: Chemical Injection	\$508,000	N/A
Sub - Total	\$3,344,000	\$1,329,000
Total Remedy Cost		\$ 4,673,000

Table 15 (con't) - Estimated Cost of the Remedy

ALTERNATIVE S2/G2, INSTITUTIONAL CONTROLS AND MONITORING COST ESTIMATE				
Remedy Component				Component Cost
Monitoring Plan Development				10,000
Deed Restrictions				50,000
New Well Installation and Well Maintenance				40,000
Annual Groundwater Monitoring (45 Wells for VOC, SVOCs, Metals)		45,000/yr		560,000*
Maintenance/Inspections		12,000/yr		150,000*
Total Remedy Cost (30 Year, PV)				\$ 810,000
*Assumes 30 years @ 7% discount rate				
Key Assumptions:				
Well Network and Analyte list remains constant for 30 years; maximum of 3 new wells to be installed.				

Table 15 (con't)- Estimated Cost of the Remedy

ALTERNATIVE S4 SVE WITH COMBINED COVER COST ESTIMATE				
Remedy Component	Basis Unit	No. Units	Est. Unit Cost	Component Cost
Site Prep (Demo, Trailer Removal etc.)		1	150,000	150,000
RCRA Cover Cost @ 3 Acres	27% Alt. 3B	27%	3,836,000	1,036,000
Soil Cover @ 8 Acres	73% Alt 3A	73%	1,099,000	802,000
Mechanical System + Installation	Lump Sum	1	350,000	350,000
Total Construction Cost (TCC)				2,338,000
Construction QC & Oversight	10% TCC	1		234,000
Remedial Design	7% TCC	1		164,000
Annual O&M - Cover (30 yr)		30	40,000	496,000
Annual O&M - SVE (5 yr)		5	30,000	123,000
Total Remedy Cost (30 Year, PV)				\$ 3,355,000
Key Assumptions				
SVE operation for 5 years, then converts to landfill gas vents				
No off-gas treatment				

Table 15 (con't) - Estimated Cost of the Remedy

ALTERNATIVE G3 GROUNDWATER REMEDIATION CHEMICAL INJECTION COST ESTIMATE			
Remedy Component			Component Cost
Treatability Study, Permitting, and Pilot Test			75,000
Soil Screening in Proposed Injection Areas			15,000
Cost per Injection Event			
Mobilization Injection and Chemical	3,000		
Costs 5 days @8,000=	40,000		
Oversight and Reporting	7,000		
Cost per Event	50,000		
Injection Events 6	50,000		300,000
Interim Monitoring Events 12	6,000		72,000
Total Construction Cost (TCC)			462,000
Remedial Design	10% TCC	1	46,000
and Interim Assessments			
Total Remedy Cost			\$ 508,000
Key Assumptions:			
Injection into saprolite groundwater			
Injection events occur at 6 month intervals			
Approximately 4 to 6 injection events required			
Pilot test may be combined with first injection event			

L.3 Expected Outcomes of the Selected Remedy

The selected remedy will reduce future unacceptable risks to human health and the environment by preventing or minimizing further exposure to contaminated soils and groundwater impacted by the closed MSWL and the former Aqua-Tech operation. In summary, the remedy provides for the construction of an engineered containment cover (cap) in accordance with the Presumptive Remedy combined with in-situ treatment of soil to primarily prevent or mitigate direct human exposure to Site soils and/or the MSWL contents. Furthermore, the selected remedy will control migration of contaminants from the Site to surface water by eliminating contact of stormwater runoff with MSWL contents and Site soils. In addition, the remedy provides for the restoration of the contaminated groundwater by implementing in situ treatment of groundwater to attain clean-up levels after 3 to 5 years. Institutional controls will be implemented to control Site use. Environmental monitoring will be implemented to evaluate the effectiveness of the remedy. Use restrictions on such groundwater are part of the selected remedy and will be in place until the groundwater performance standards are attained. Use of the landfill property will be indefinitely limited to ensure that the engineered containment cover remains intact and continues to prevent migration of contaminated soils and reduce infiltration of water that could be released into the groundwater.

L.4 Final Clean-up Levels

The BRA identified specific clean-up levels for the surface and subsurface soils and groundwater. As previously stated, clean-up levels for air were not derived, since the air itself cannot reasonably be remediated. The final Clean-up Levels for surface and subsurface soils and groundwater, basis for the clean-up levels, and risk at clean-up level (if appropriate) are included in Tables 16 and 17.

Table 16
Soil Clean-up Levels

Available Use : Commerical/Industrial Controls to Ensure Restricted Use (if applicable): IC - Airport Environs Area Zoning Ordinance, March 1996, Deed Restrictions			
Chemical of Concern	Clean-up Level	Basis for Clean-up Level	Risk at Clean-up Level
<u>Surface Soil</u>			
Iron	137, 000 mg/kg	Baseline Risk Assessment	HI = 1
Lead	598 mg/kg	Baseline Risk Assessment	Not Available
Mercury	9 mg/kg	Baseline Risk Assessment	HI = 1
<u>Sub-Surface Soil</u>			
Aroclor - 1242	22.8 mg/kg	Baseline Risk Assessment	Cancer Risk = 1×10^{-6}
Iron	137,000 mg/kg	Baseline Risk Assessment	HI = 1
Thallium	35 mg/kg	Baseline Risk Assessment	HI = 1
Trichloroethene	5 mg/kg	Baseline Risk Assessment	Cancer Risk = 1×10^{-6}

Table 17
Groundwater Clean-up Levels

Available Use : Residential Controls to Ensure Restricted Use (if applicable): IC - Airport Environs Area Zoning Ordinance, March 1996 , Deed Restrictions			
Chemical of Concern	Clean-up Level	Basis for Clean-up Level	Risk at Clean-up Level
1,1,2,2-Tetrachloroethane	2 ug/l	Federal MCL	Not Available
1,1-Dichloroethene	7 ug/l	Federal MCL	Not Available
Benzene	5 ug/l	Federal MCL	Not Available
cis-1,2-Dichloroethene	70 ug/l	Federal MCL	Not Available
Tetrachloroethene	5 ug/l	Federal MCL	Not Available
Trichloroethene	5 ug/l	Federal MCL	Not Available
Vinyl Chloride	2 ug/l	Federal MCL	Not Available

M. STATUTORY DETERMINATIONS

M.1 Protection of Human Health and the Environment

The selected remedy will adequately protect human health and the environment through treatment, engineering controls, and/or institutional controls (NCP)§300.430(f)(5)(ii)). Soil and groundwater contaminants concentrations posing cancer risks of greater than 1×10^{-6} or Hazard Quotients greater than 1, will be contained and/or treated on-site. Notices will be placed on deeds warning potential property purchasers of potentially contaminated groundwater. Environmental monitoring will be implemented to evaluate the effectiveness of the remedy. All of these measures will reduce the risks to both human and ecological receptors. They are not expected to cause unacceptable short-term risks or cross-media impacts.

M.2 Compliance with Applicable or Relevant and Appropriate Requirements

The Federal and State ARARs, potential ARARs and requirements which are To Be Considered, that are relevant to the Site and the Selected Remedy are presented in Table 18. The selected remedy will comply with all ARARs in Table 18 that are listed as either “Applicable” or “Relevant and Appropriate” under the “Status” column.

Table 18 - Summary of Potential Applicable or Relevant and Appropriate Requirements

Standard Requirement Criteria or Limitation	Citation	Description	Applicable	Relevant and Appropriate	Comments
		<i>Federal</i>			
		<i>Safe Drinking Water Act (40 USC § 300)</i>			
National Primary Drinking Water Standards	40 CFR Part 141	Maximum contaminant levels (MCLs) are established health- based standards for public water systems.	No	Yes	Not <u>applicable</u> because no public water supply is affected. The MCLs for organic and inorganic contaminants are <u>relevant</u> and <u>appropriate</u> for groundwater at the site since it is a potential future drinking water source.
National Secondary Drinking Water Standards	40 CFR Part 143	Establishes secondary maximum containment levels (MCLs) as aesthetic or other welfare-based standards and not health-based standards for public water systems.	TBC	TBC	Not <u>applicable or relevant and appropriate</u> because the secondary drinking water standards are not enforceable health-based standards; therefore, they are "to be considered" (TBC) guidelines.
Maximum Contaminant Level Goals (MCLGs)	40 CFR Part 141	Establishes targets for drinking water quality at levels of no known or anticipated adverse health effect.	TBC	TBC	Not <u>applicable or relevant and appropriate</u> because the MCLGs are targets and not enforceable standards. The MCLGs for organic and inorganic contaminants, therefore, "to be considered" (TBC) guidelines.
		<i>Clean Water Act (33 USC 1251 et seq)</i>			
National Pollutant discharge Elimination System (NPDES) Wastewater	40 CFR Part 122 40 CFR Part 125	Sets criteria for discharge of treated water to surface water.	Yes	Yes	NPDES standards are <u>applicable or relevant</u> and <u>appropriate</u> for any alternative where groundwater is treated and either directly or indirectly discharged to surface water.

Table 18 (con't) - Summary of Potential Applicable or Relevant and Appropriate Requirements

Standard Requirement Criteria or Limitation	Citation	Description	Applicable	Relevant and Appropriate	Comments
		<i>Clean Water Act (33 USC 1251 et seq)</i>			
National Pollutant Discharge Elimination System (NPDES)- Storm Water	40 CFR Part 122	Sets criteria for discharge of storm water to surface water.	Yes	Yes	NPDES standards are applicable or relevant <u>and appropriate</u> for any construction activities during capping.
Water Quality Criteria	40 CFR Part 131	Sets criteria for water quality based on effects on aquatic organisms and human health.	No	Yes	The AWQC for organic and inorganic contaminants are <u>relevant and appropriate</u> .
		<i>Resource Conservation and Recovery Act (RCRA), as amended (42 USC § 6905, 6912, 6925, 6925)</i>			
Identification and Listing of Hazardous Waste	40 CFR Part 261	Provides the framework for determining whether or not a solid waste is classified as hazardous.	Yes	No	Only applicable or relevant and appropriate if hazardous waste is generated for off-site disposal
Hazardous Waste Generator Requirements	40 CFR Part 262	Provides framework for storing and manifesting solid waste classified as hazardous.	Yes	No	Only <u>applicable or relevant and appropriate</u> if hazardous waste is generated for off-site disposal
Transportation of Hazardous Waste	40 CFR Part 263	Provides framework for shipping of waste classified as hazardous.	Yes	No	Only <u>applicable or relevant and appropriate</u> if hazardous waste is generated for off-site disposal

Table 18 (con't) - Summary of Potential Applicable or Relevant and Appropriate Requirements

Standard Requirement Criteria or Limitation	Citation	Description	Applicable	Relevant and Appropriate	Comments
		Provides standards for off-site treatment and disposal of waste classified as hazardous.	Yes	No	Only <u>applicable or relevant and appropriate</u> if hazardous waste is generated for off-site disposal
Land Disposal Requirements	40 CFR Part 268				
		Provides standards for municipal solid waste landfills	No	Yes	Closure requirements for municipal landfills are relevant and appropriate for this site.
RCRA Subtitle D Regulations	40 CFR Part 258				
		Clean Air Act 40CFR 50			
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Sets primary and secondary air standards at levels to protect public health and public welfare.	No	No	May be <u>relevant and appropriate</u> if on-site treatment units are part of remedial actions.
National Emissions Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61	Provides emissions standard for hazardous air pollutants for which no ambient air quality standards exists.	No	No	May be relevant or appropriate if on-site treatment units are part of remedial actions.

Table 18 (con't) - Summary of Potential Applicable or Relevant and Appropriate Requirements

Standard Requirement	Citation	Description	Applicable	Relevant and Appropriate	Comments
<i>Department of Transportation (DOT) Hazardous Materials Transportation Act (49 USC 1801)</i>					
Department of Transportation (DOT) Hazardous Materials Transportation Act	49 CFR Parts 171-179	Regulates off-site transportation of specific hazardous chemicals and wastes.	No	Yes	<u>Applicable</u> only if remediation involves removal of waste from the site.
<i>South Carolina</i>					
<i>South Carolina Air Pollution Control Regulations (R. 61-61)</i>					
Air Pollution Control Standards	R.61-61.5	Permits and Establishes Air Pollution Control Standards for hazardous pollutants and particulate matter.	No	No	<u>Applicable or relevant and appropriate</u> for certain landfill gas treatment methods, such as flares.
Ambient Air Quality Standard	R.61-62.5	Standards for emissions of particulate matter, SO _x , NO _x , and CO.	No	No	May be <u>applicable or relevant and appropriate</u> for certain groundwater treatment methods.
Emissions from Process Industries	R.61-62.5 Standard No. 4	Standards for emissions of particulate matter and SO _x .	No	No	May be <u>applicable or relevant and appropriate</u> for certain landfill gas treatment methods.
Lowest Achievable Emission Rate (LAER) for VOCs	R.61-62.5 Standard No. 5.1	Standards for emissions of VOCs.	No	No	Unlikely to be <u>applicable or relevant and appropriate</u> due to the threshold quantities.

Table 18 (con't) - Summary of Potential Applicable or Relevant and Appropriate Requirements

Standard Requirement Criteria or Limitation	Citation	Description	Applicable	Relevant and Appropriate	Comments
Prevention of Significant Deterioration	R.61-62.5 Standard No.7	Standards for emissions of particulate matter and SO _x	No	No	<u>Unlikely to be applicable or relevant and appropriate</u> due to the threshold quantities.
Toxic Air Pollutants	R.61-62.5 Standard No. 8	Standards for emissions for hazardous air pollutants.	No	No	<u>Applicable or relevant and appropriate</u> for certain groundwater treatment methods.
Good Engineering Practice Stack Height	R.61-62.7	Standards for establishing stack heights for air discharges.	No	No	<u>Applicable or relevant and appropriate</u> for certain landfill gas or groundwater treatment methods.
Water Pollution Control Permits	R.61-9	Standards for NPDES permits for discharge of wastewater to surface water or POTWs and discharge of storm water.	No	No	<u>Applicable or relevant and appropriate</u> for most groundwater treatment methods and possibly for storm water runoff.
Standards for Wastewater Facility Construction	R.61-67	Standards for construction of facilities to treat water subject to NPDES requirements.	No	No	<u>Applicable or relevant and appropriate</u> for most groundwater treatment methods.
South Carolina Hazardous Waste Management Regulations.	R.61-79	Permits and establishes regulations for locating, operating, inspecting, and closing Hazardous Waste	No	No	Similar to the Federal Resource Conservation and Recovery Act (RCRA). <u>Only applicable or relevant and appropriate</u> if waste is generated for off-site disposal.

Table 18 (con't) - Summary of Potential Applicable or Relevant and Appropriate Requirements

Standard Requirement Criteria or Limitation	Citation	Description	Applicable	Relevant and Appropriate	Comments
South Carolina Solid Waste Management Regulations for Municipal Landfills	R.61-107.258	Permits and establishes regulations for locating, operating, inspecting, and closing Solid Waste Facilities	No	Yes	Closure requirements for municipal landfills are relevant and appropriate for this site.
South Carolina Groundwater Use Act	Title 49 Chapter 5	Regulates and protects groundwater use	Yes	No	<u>Applicable</u> to remediation of groundwater at the Site.
South Carolina Well Standards	R.61-71	Establishes general rules and standards applicable to waters.	No	No	Potentially <u>applicable or relevant and appropriate</u> for groundwater recovery.

M.3 Cost Effectiveness

This section explains how the Selected Remedy meets the statutory requirement that all Superfund remedies be cost-effective. A cost-effective remedy in the Superfund program is one whose “costs are proportional to its overall effectiveness” (NCP)§300.430(f)(1)(ii)(D)). The “overall effectiveness” is determined by evaluating the following three of the five balancing criteria used in the detailed analysis of alternatives: (1) Long-term effectiveness and permanence; (2) Reduction in toxicity, mobility and volume (TMV) through treatment; and, (3) Short-term effectiveness. “Overall effectiveness is then compared to cost” to determine whether a remedy is cost-effective (NCP §300.430(f)(1)(ii)(D)). The selected remedy is considered cost effective because it is a permanent solution that reduces human health risks to acceptable levels at less expense than some of the other permanent, risk reducing alternatives evaluated.

M.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable (MEP)

The selected remedy provides permanent solutions for all media and treatment for soil and groundwater. It does not provide for treatment of air, since the air itself cannot reasonably be remediated. However, all of the modeled air concentrations were less than the current SC DHEC Maximum Ambient Air Concentrations. Furthermore, active remedial alternatives being considered for soil and/or groundwater will further reduce chemical concentrations in the ambient air, if any, attributable to the Site. In addition, Institutional Controls with Monitoring is being selected to restrict use and development of the Site to minimize public exposure to residual contaminants, ensure the long-term integrity of the remedy and assess the effectiveness and integrity of the remedy. These are permanent solutions.

M.5 Preference for Treatment as a Principal Element

Although there is no principal threat waste at this Site, the selected remedy for soil and groundwater includes treatment. In situ Soil treatment in the former Process Distillation Area to reduce the mass of VOCs in shallow soils throughout this area and in situ groundwater treatment by chemical injection to immediately reduce the contaminant mass and enhance the long term biodegradation of residual VOCs in groundwater.

M.6 Five-Year Review Requirements

The Selected Remedy includes a Presumptive Remedy for the landfill at the Site. Therefore, upon completion of this remedy, hazardous substances, pollutants, or contaminants will remain on-site under the landfill cap and will limit use of the property. Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after commencement of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

N. DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for the Site was released for public comment on July 20, 2003. The public comment period was from July 27, 2003, to August 25, 2002. The Proposed Plan identified, Soil and

Groundwater Alternative S2/G2 (Institutional Controls with Monitoring), Soil Alternative S4 (Site Cover with In Situ Soil Treatment) and Groundwater Alternative G3 (In Situ Groundwater Treatment). Only one written comment was received on the Proposed Plan, and only a few comments were provided in the public meeting. Therefore, it is difficult to determine community acceptance of the alternatives. One person recommended in writing to select Alternative G4 - Natural Attenuation for the entire Site. There were no vocalized objections to any of the alternatives. Of those comments expressed, most were related to costs and source of funding for the cleanup. EPA reviewed the verbal comments submitted during the public meeting, which was transcribed by a court reporter. Based upon this review, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

However, four changes are reflected in this Record of Decision that differ slightly from the information presented to the public in the Proposed Plan. The changes are as follows:

- Under the Section 'Summary of Human Health Risks From the Site' - an unacceptable cancer risk exists for the future commercial worker scenario.
- Under the Section 'Summary of Human Health Risks From the Site' - an unacceptable cancer risk exists for the future irrigation worker scenario.
- Under the Section 'Remedial Action Objectives - Soil' - The soil clean-up level (cleanup) for Aroclor 1242 is 23 mg/kg instead of 9 mg/kg.
- Under the Section 'Remedial Action Objectives - Soil' - The soil clean-up level (cleanup) for Mercury is 9 mg/kg instead of 73 mg/kg.
- Under the Section 'Remedial Action Objectives - Soil' - The soil clean-up level (cleanup) for Trichloroethene is 5 mg/kg instead of 54.3 mg/kg.

These changes do not affect the characterization of the Site presented in the RI, the characterization of Site risks presented in the BRA or the remedy alternatives presented in the FS. Therefore, as previously stated, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

PART III: RESPONSIVENESS SUMMARY

Only one written comment was received on the Proposed Plan, and only a few comments were received during the public meeting that was held on August 5, 2003. A copy of the transcript will be placed in the Administrative Record. A summary of the major comments are as follows:

Several people wanted to know whether Maple Creek had been affected. **RESPONSE:** The surface water and sediment analytical data demonstrate that the Site and adjacent properties to the north may have impacted the quality of sediments and surface water in the east drainage ditch. However, there are no concentrations of organic chemical compounds or metals in the sediment or surface water of Maple Creek which exceeded the higher of background or screening criteria. Therefore, there has been no significant impact on the sediments or surface water of Maple Creek from Site activities.

One person wanted to know who would make the decision about what alternative to use. The person was also concern about the State of South Carolina's budgetary situation and who would fund the cleanup. **RESPONSE:** EPA, the lead agency for site activities, and the South Carolina Department of Health & Environmental Control (SCDHEC), will select a final remedy for the site after reviewing and considering all information submitted during the 30-day public comment period. EPA, in consultation with SCDHEC, may modify the Preferred Alternative or select another response action presented in this Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all the alternatives presented in this Proposed Plan. Furthermore, EPA intends to negotiate a consent decree for Remedial Design and Remedial Action (RD/RA) with the PRPs

One person asked questions regarding the source of the funding for the site response action. **RESPONSE:** The funding for the response actions at the Site have largely come from the Aqua-Tech Potentially Responsible Party Group (PRP Group). Under a Unilateral Administrative Order on Consent (UAO), the PRP Group was obligated to pay for the cost of the Removal Action. Under an Administrative Order on Consent (AOC) for the remedial investigation and feasibility study (RI/FS), the PRP Group is obligated to pay USEPA's oversight costs of the RI/FS as well as the cost of the RI/FS. EPA intends to negotiate a Consent Decree for Remedial Design and Remedial Action (RD/RA) with the PRPs.

One person was concern about the amount of time the project has taken and wanted to know the projected project schedule. **RESPONSE:** EPA intends to negotiate a consent decree for Remedial Design and Remedial Action with the PRPs. The Consent Decree will require the submittal of a work plan that includes an expeditious schedule for completion of there remedial action activities. It is anticipated that design activities would be completed by Fall 2004. Actual construction activities may commence as early as Fall 2004.

One person wanted to know if there was a methane problem. **RESPONSE:** A landfill gas assessment was conducted to estimate maximum landfill gas emission rates and exposure point concentrations. Comparison of the predicted maximum emission rates to South Carolina's de minimis emission criteria showed that only benzene and vinyl chloride exceeded the criteria. Based on the results of the air dispersion model, the resulting 24 hour average concentrations are below South Carolina Maximum Ambient Air Concentrations (MAACs). Therefore, landfill gas emissions do not pose a significant risk to on-Site or off-Site receptors.

One person wanted to know about chemical injection. **RESPONSE:** Chemical injection will treat residual contamination in groundwater in a reasonable period of time. There are different chemicals available, with each effective for different contaminants and groundwater environments (i.e., pH, oxidation-reduction

potential, organic content). For treatment of chlorinated solvents, it has been documented that using oxidants, such as potassium permanganate and/or sodium persulfate, and reductants, such as , such as lactates and vegetable oils, sodium lactate or Hydrogen Release Compound (HRC , a proprietary polylactate compound), enhance biological dechlorination and are particularly effective. Another similar process for enhanced biological dechlorination include injection of a material similar to molasses. In addition, the chemicals may be used to treat both groundwater and soils. The process is completed in the ground, with no process residuals formed requiring handling or disposal.

One person recommended in writing to select Alternative G4 - Natural Attenuation for the entire Site since there is no current risks (although there are future unacceptable risks) at the Site. **RESPONSE:** Based on the RI, BRA and the ERA, the Aqua Tech Site poses future unacceptable risks to several receptor populations (future child/adult residents, commercial, irrigation and construction workers). Therefore, the response action selected in this Record of Decision is necessary to protect public health or welfare or the environment from actual or threaten releases of pollutants or contaminants from the Site which may present and imminent and substantial endangerment to public health or welfare.

PART IV: REFERENCES

All documents reviewed are included in Appendix G of this ROD.